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Range of Variation in Estimates of Dry Weight for Planktonic Crustacea and Rotifera from Temperate North American Lakes

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ABSTRACT

Malley, D.F., S.G. Lawrence, M.A. MacIver, and W.J. Findlay. 1989. Range of variation in estimates of dry weight for planktonic Crustacea and Rotifera from temperate North American lakes. Can. Tech. Rep. Fish. Aquat. Sci. 1666: iv + 49 p.

Dry weights of individual zooplankters are known to vary from lake to lake, with season, with variability in abundance of food, or from predation and competition. Furthermore, methodological differences in determining weights probably contribute to the variation.

Dry weights calculated from measurements of three body dimensions are reported here for crustaceans and rotifers from four Precambrian Shield lakes in the Experimental Lakes Area in northwestern Ontario, from Clay Lake near Dryden, Ontario and from a prairie pothole lake near Erickson, Manitoba. As well, directly-obtained dry weights are presented for planktonic crustaceans from three Laurentian Great Lakes. Length-weight regressions are presented for copepods and cladocerans. Some new data on the effects of season, lake depth, method of preservation, and on variability of application of our method among technicians are presented.

Ranges of variation in dry weight of individual zooplankters are examined by drawing on these data and on those in the published literature. For each of several cladoceran species, different authors report as large as 10-fold range in weight for individuals of a given length. For copepods, the corresponding range is as high as three-fold.

Key words: Cladocera; Copepoda; Calanoida; Cyclopoida; Rotifera; Experimental Lakes Area; Erickson-Elphinstone District; Clay Lake; Lake Huron; Lake Ontario; Lake Superior.

RÉSUMÉ

Malley, D.F., S.G. Lawrence, M.A. MacIver, and W.J. Findlay. 1989. Range of variation in estimates of dry weight for planktonic Crustacea and Rotifera from temperate North American lakes. Can. Tech. Rep. Fish. Aquat. Sci. 1666: iv + 49 p.

On sait que le poids sec des organismes zooplanctoniques varie d'un lac à l'autre, d'une saison à l'autre, et ce à cause de la variabilité de l'abondance des aliments, ou à cause de la prédation et de la compétition. De plus, des différences dans les méthodes de détermination du poids contribuent probablement à cette variation.

On donne dans le présent rapport le poids sec calculé à partir des trois dimensions corporelles pour des crustacés et de rotifères provenant de quatre lacs du Bouclier précambrien, dans la Région des Lacs Expérimentaux situés dans le nord-ouest de l'Ontario, du lac Clay près de Dryden, dans l'Ontario, et d'une mare de prairie près d'Erickson, au Manitoba. Des poids secs obtenus directement pour des crustacés provenant de trois Grands lacs laurentidiens sont aussi présentés. On présente des régressions de longeur-poids pour des copépodes et des cladocères. Le rapport renferme quelques données sur les effets saisonniers, les effets de la profondeur des lacs, la méthode de préservation, ainsi que sur la variabilité de l'application de notre méthode par les techniciens.

Les gammes de variation du poids sec des organismes zooplanctoniques sont établies à partir de ces données et de celles de la documentation publiée. Pour chacune des nombreuses espèces de cladocères, différents auteurs signalent que pour une longueur donnée, le poids varie de 1 à 10 d'un individu à l'autre, alors que pour les copépodes, le poids varie de 1 à 3.

Mots-clés: Cladocères; Copépodes; Calanidés; Cyclopidés; Rotifères; Région des Lacs Expérimentaux; District d' Erickson-Elphinstone; lac Clay; lac Huron; lac Ontario; lac Superior.

INTRODUCTION

Understanding of zooplankton community structure and trophic relationships requires that we know the biomass of individuals at various points in the life cycle. For crustaceans, growth and development can produce large changes in body size over the life cycle. In cladocerans, growth is associated with small developmental changes such that individuals of various ages are not morphologically distinct (direct development). Nevertheless, the oldest individuals weigh 10-20 times as much as neonates. On the other hand, growth in copepods is associated with large developmental changes (indirect development) such that 12 life stages of increasing body size are distinguishable. In rotifers, growth and development produce much less change in body size and morphology.

Our studies therefore focus on instar stage in copepods, body length in cladocerans and at the species level in rotifers. Although growth and development are primary influences on individual biomass, body size at given ages or life stages is influenced by a number of factors including season (Hawkins and Evans 1979; Reed and Aronson 1989), food (Makarewicz and Likens 1979), competition (Hall et al. 1970), lake trophy (Dumont et al. 1975; Bottrell et al. 1976; Yan and Mackie 1987), and fecundity and body fat content (Yan and Mackie 1987).

We examine here the range of variation measured in the dry weights of life stages of zooplankton taxa from freshwater lakes of central and eastern Canada from 1) estimations of dry weight biomass of individual crustaceans from Experimental Lakes Area (ELA) Lakes 224, 227, and 302; from Clay Lake, near Dryden, Ontario; and from Lake 885, near Erickson, Manitoba using the indirect method of Lawrence et al. (1987); 2) from estimations of biomass of individual rotifers from five lakes; 3) examination of unpublished data on biomass of crustaceans from the Laurentian Great Lakes; and 4) reference to the published literature. The ELA data presented are based on material preserved in a final concentration of 4% formalin. We report effects of two preservatives on estimates of the dry weight biomass of cladocerans of ELA lakes 226 and 239 and we present preliminary data on the effects of season and of lake depth on the dry weight biomass of copepods.

MATERIALS AND METHODS

SITES AND METHODS OF SAMPLING

Naturally oligotrophic Lakes 223, 224, 226, 227, 239 and 302 are located on the Precambrian Shield in the ELA, northwestern Ontario (Table 1). Lake 223 has been experimentally acidified beginning in 1976. Although trace amounts of six radioactive metals were added to Lake 224 in 1976, it has not otherwise been chemically altered. It serves as a reference lake for whole lake experiments. Lake 226 is a double-basin lake divided by a sea curtain into northeast and southwest basins. The northeast basin received additions of P, N and C, and the southwest basin, N and C, from 1973 to 1980. Lake 227 has been artificially enriched with N and P each year since 1969. The watershed of unmanipulated reference Lake 239 has been affected by forest fire and blowdown. The two basins of Lake 302 were separated by a curtain. The north basin (302N) was then subjected to additions of C, N and P for several years (Schindler et al. 1980b). When the barrier between north and south basins was removed, chemical variables of the north basin returned to pre-manipulation values within two years. In 1980, the basins were again separated by a curtain, and sulphuric acid was added to 302S from 1982 to the present. Nitric acid was added to 302N from 1982 to 1987 and, subsequently, hydrochloric acid was added from 1987 to the present.

Clay Lake, a riverine lake in the English-Wabigoon River system of northwestern Ontario, was industrially contaminated with mercury (Table 1). Lake 885 is a saline, hypereutrophic prairie pothole lake, without inflow or outflow located south of Riding Mountain National Park in southwestern Manitoba (Table 1). It contains no endogenous fish but was stocked with rainbow trout fingerlings annually from 1974 to 1979.

Zooplankton sampling methods for ELA lakes are described by Chang et al. (1980, 1981, 1983) and Lawrence and Holoka (1987). Impoundments in Lake 223 (10 m diameter, 2 m depth) were sampled by net (Lawrence 1980). Clay Lake and large impoundments in that lake were sampled by Patalas-Schindler trap as described in Lawrence and Holoka (1983). Lake 885 was sampled using a modified Pennak sampler as described in Salki (1981). Unless otherwise indicated, zooplankton samples used in this study from Lakes 223, 224, 226, 227, 239, 302, Clay Lake, and Lake 885 were preserved in a final concentration of 4% formalin.

Zooplankton samples from Lake 223 for measurement of individuals were selected from those taken during the ice-free season from the open lake, prior to acidification in 1974, and during acidification, 1978 and 1980. Impoundments in Lake 223 were sampled only in summer, 1978 (Lawrence 1980). The zooplankton measured from Lake 224 were sampled during 1975 to 1978. Zooplankton from Lake 227 were selected randomly with respect to season, depth and year, 1974 to 1978, in order that single average dry weight estimates could be applied to a given species or life stage uniformly over all sampling dates and locations. Zooplankton taken from Lake 302 and 40 L impoundment vessels incubated in Lake 302 were from the ice-free seasons of 1981 and 1983 (Lawrence and Holoka 1987). Measurements were made on the zooplankton of Clay Lake taken from populations inside and outside of impoundments between May and September 1978 (Lawrence and Holoka 1983). Specimens from Lake 885 were collected from the lake and from populations impounded in 20 L semi-continuously flowing systems between 6 and 21 June 1979. Since the time span was narrow, certain life phases did not appear.

Species composition of the zooplankton communities of Lakes 223, 224, 226, 227, and 239 were described by Patalas (1971), Malley and Chang (1980), Malley et al. (1982), Chang et al. (1983) and Malley et al. (1988). The crustacean zooplankton communities of Lake 302, Clay Lake and Lake 885 were described by Ramsey (1985), Lawrence and Holoka (1983) and Salki (1981), respectively. Rotifers were identified using Chengalath et al. (1971), Ruttner-Kolisko (1974) and Ward and Whipple (1959). Rotifers were rare in Lake 885 at the time of sampling and were not measured.

MEASUREMENTS AND CALCULATION OF DRY WEIGHT

Measurements were made to the nearest 0.008 mm with an ocular micrometer along the three principal axes of individuals, i.e. length (anterior-posterior), width (lateral), and depth (dorsoventral) (Fig. 1) using a Zeiss binocular microscope at magnifications of 31 to 200X (Lawrence et al. 1987). In general, appendages such as setae or spikes were not measured but formulae were adjusted to take bulky appendages into account. Individual species of cladocerans and rotifers were measured. Copepod life stages were each measured separately for the various species. Eggs of some species were measured.

A simple geometric figure (Table 2) was judged to approximate the shape of each species or life stage as observed under the microscope. The volumes of these shapes for crustaceans and rotifers were calculated using measured dimensions, converted to wet weight by assuming that 1 mm^3 weighs 1 mg, and thence to dry weight assuming the latter to be 7% of live weight for all species, except for Asplanchna sp., for which the conversion factor was 4% (Dumont et al. 1975).

Measurements were taken on up to 150 randomly-selected organisms of a species or life stage and the biomass of each organism was calculated using the geometric formulae. As described by Lawrence et al. (1987), the formulae were adjusted, if necessary, to agree with directly determined dry weights of adult copepods and cladocerans. For example, Daphnia longiremis, from Lake 302, not discussed in Lawrence et al. (1987), was assigned an initial formula of $4/3\pi abc$. This resulted in a ratio of actual dry weight to calculated dry weight of 0.66. The agreement was improved to a ratio of 0.94 by modifying the formula for this organism to $4/3\pi a0.7bc$. The formulae in Table 2 include the adjusted formulae (B to I).

Expression of body shape as a geometric figure was previously done by Ruttner-Kolisko (1977) for rotifers. The formulae we use to calculate rotifer biomass are generally less complex than those of Ruttner-Kolisko in that they do not include separate calculations for appendages. In Table 3 we show that the dry weights we calculate using our formulae are very similar to those calculated from Ruttner-Kolisko's formulae excluding the calculations of the volumes of appendages.

EFFECT OF PRESERVATIVE ON CALCULATED DRY WEIGHT

Lawrence et al. (1987) hypothesized that the discrepancy between calculated dry weight and measured dry weight for cladocerans was due to distortion upon preservation. Haney and Hall (1973) showed that Daphnia preserved in sugar-formalin were significantly less wide than those preserved in formalin.

To test the effect of two preservatives on body dimensions of cladocerans, some zooplankton samples taken from Lake 226 (NE and SW basins) and Lake 239 were preserved in the field in a final concentration of 5 to 10% formalin while others were preserved in sugar-formalin (final concentration 26-50 $g \cdot L^{-1}$ sugar in 5 to 10% formalin). Length, width and depth were measured on individuals of three cladoceran species and weight was calculated according to formula H (Table 2). To examine if width, depth, or calculated dry weights were affected by the preservative, we used analysis of covariance to test for differences between preservatives in length-width, length-depth and length-weight relationships. We assumed that organism length was not differentially altered by the two preservatives. Mean lengths of organisms in the two treatments were compared by analyses of variance to determine whether the populations of organisms sampled differed in mean length.

The width and, consequently, the calculated weights for D. retrocurva were lower by 14 to 24% in sugar-formalin than in formalin alone (Table 4). The difference in weight due to preservative was greater for the small D. retrocurva (36% lower) than for the large (13% lower). For D. galeata mendotae both widths and depths were lower in sugar-formalin resulting in 28% lower overall weight in the latter preservative. Again the difference was greatest for the smaller organisms.

Generally, the dimensions of Diaphanosoma birgei and the calculated weights were not affected by preservative. Bosmina longirostris had lower width and depth in sugar-formalin and this generally resulted in lower calculated weight in this preservative.

Thus, our data confirm the finding of Haney and Hall (1973) that sugar-formalin significantly reduces the width dimension of daphnids. The gaping of the carapace, associated with preservation in formalin, causes the volume and the calculated weight to be overestimated (Lawrence et al. 1987). However, the decrease in volume associated with reduced gaping in sugar-formalin is not sufficient to reduce calculated dry weights to the observed dry weight. The empirical correction factors used by Lawrence et al. (1987) are generally larger than the proportion attributable to gaping alone. It is important to note that the formulae reported in Table 2 are valid for formalin-preserved Daphnia and Bosmina and not for those preserved in sugar-formalin.

COMPARISON OF MEASUREMENTS BETWEEN WORKERS

Since calculated biomass is dependent upon the accuracy of measurement, measurements made on the same specimens by two workers were compared. The two workers measured the same 10 specimens of each of Cyclops bicuspidatus thomasi and Holopedium gibberum (Table 5). There were few significant differences in average measurements and calculated dry weight between the two workers. The measurements of one worker were not consistently larger or smaller than those of the other. There appears to be variability in weight estimates due to inaccuracies in the process of measuring but little worker bias.

STATISTICAL ANALYSIS

Dimensional data were analyzed by standard statistical methods. To compare dry weights of organisms taken from different lake depth strata or season, we used analysis of variance.

Lengths and calculated weights were transformed by using natural logarithms to normalize the distributions and reduce inequality among variances (Persson and Ekbohm 1980; Prepas 1984). Ln dry weight of the zooplankters was regressed against ln length according to the equation:

$$\ln w = \ln a + b \ln L$$

where lnw is the natural logarithm of the dry weight in µg; lna is an estimate of the y-intercept; b is an estimate of the slope; and lnL is the log-transformed length measurement in mm. Confidence limits around the slope, residual mean squares, and the variance of lnL were calculated according to standard linear regression methods. Slopes of regressions were considered to be significantly different if their confidence intervals did not overlap.

Once the regression equation has been prepared for a species or life stage, it can in turn be used to calculate average dry weight from a mean of log-transformed length ($\overline{\ln L}$) according to McCauley (1984):

$$\ln w = \ln a + b\,\overline{\ln L}$$

To do this, Persson and Ekbohm (1980) and McCauley (1984) suggest using calculations to avoid the bias which accompanies the conversion of the average lnw to weight in arithmetic units. Bird and Prairie (1985), however, evaluated this use of $\overline{\ln L}$ and found that weight may be significantly underestimated. They suggest that the lnw of each lnL be obtained, that these values be transformed to arithmetic units using their equation to avoid bias, and that the arithmetic weight be averaged to obtain a mean weight.

Statistical significance was accepted at the $P = 0.05$ level.

RESULTS

COPEPODS

Estimated dry weights individual life stages

The dimensions and calculated weights of calanoid copepods of the genus Diaptomus and of Epischura lacustris are reported in Table 6. Diaptomus minutus occurred in five of the six lakes whereas D. oregonensis occurred only in Clay Lake, D. sicilis only in Lake 224, and D. siciloides only in Lake 885. Where adults of only one species of calanoid were present in a sample, nauplii in that sample were designated as that species. However, most samples contained more than one species of calanoid, including occasionally the large predator, E. lacustris. Therefore, in Table 6, nauplii from Lake 224 represent more than one Diaptomus species and from Lake 227 are D. minutus with a few E. lacustris.

For all life cycle stages, weights of D. minutus from Lakes 223 and 302 are approximately the same. The copepodid stages of D. minutus from Lake 227 are generally heavier than those from Lakes 223 and 302. For all life stages, the weight estimates for D. oregonensis of Clay Lake and D. siciloides of Lake 885 are similar to each other. The calculated weight estimates for E. lacustris from Lakes 227 and 302 (though based on relatively few organisms) are generally similar. With the exception of one life stage, however, E. lacustris of Lake 223 are much heavier than those in the other lakes.

The dimensions and calculated weights of cyclopoid copepods are presented in Table 7. Cyclops bicuspidatus thomasi occurred in all study lakes. Tropocyclops prasinus mexicanus, the smallest of the copepods, occurred in all except Lake 885 and Mesocyclops edax occurred in all lakes except Lake 224. Cyclops vernalis occurred in Lake 302, Clay Lake and rarely in Lake 885. As for calanoids, where possible, the nauplii in Table 7 are identified to species. Variability between the weights of unspecified cyclopoid nauplii and copepodids reflects different mixtures of species. A large difference in size is always evident between female and male (F,M) adults. F:M biomass ratios range from 5.2 in M. edax (Clay Lake) to 1.7 in T. p. mexicanus (Lake 224) (Table 7). With the exception of adult females, the estimated weights for C. b. thomasi of Lakes 223 and 885 are similar. The weights of adult C. b. thomasi of Clay Lake are very similar to those of Lake 223. The mature and immature copepodids of C. b. thomasi from Lakes 224 and 227 are similar in weight. The weights of adults of this species from Lake 302 are very much lower than those from the other study lakes. All life stages of T. p. mexicanus found in Clay Lake are heavier than these organisms in ELA lakes. The copepodids of this species in Lakes 223 and 227 are similar in weight to each other but heavier than those in Lakes 224 and 302, which, in turn, are similar to each other. The weights of mature and immature copepodids of M. edax are not always similar among lakes. The adults of this species in Clay Lake and Lake 885 are up to four times heavier than those in ELA lakes.

Variation in dry weight with lake stratum and season

Dimensions and calculated weight of D. minutus in Lake 223 varied with the depth stratum from which the organism was sampled (Table 8). Organisms sampled from the epilimnion always weighed significantly less than those sampled at the same time from the hypolimnion.

The weight of C. b. thomasi varied greatly with season, particularly for females (Table 8). Similarly, D. minutus taken in May weighed less than those taken in October (Table 8).

Length-weight relationships

Generally, copepods have length:weight regressions with slopes between 2 and 3, as expected. Exceptions are those for some adult cyclopoids where slopes were between 4 and 5, and for adult D. minutus of some lakes, where slopes are below 2 (Table 9). Figure 2 shows length-weight regressions for each life stage and for combinations of life stages of C. b. thomasi. As seen in Fig. 2A showing each naupliar stage, the regression coefficients based on organisms over a short length range are variable (1.2 to 4.1). However, the regression equation based on combined N1 to N6, has a slope of 2.2, within the range of expected values. This effect of range of length is seen also in Fig. 2B for copepodids C1 to C5. Figure 2C shows that slopes above 3 for cyclopoid adults are due to an artifact from calculating a single regression through weights of both female and male organisms. As indicated in Fig. 2C, the slopes for each of females and males are lower than for the two sexes together. In Fig. 2D, the relationship for copepodids C1 to C6 has a slope of 2.5 compared with that for C1 to C5 of 2.6 and for adults of 4.1. The overall slope for N1 to C6 (Fig. 2E) is only 1.95. This low slope is an artifact of forcing a single regression line through two distinct data sets, separated by a gap in organism length. The separation is due to the metamorphosis from N6 to C1 which involves a rapid increase in organism length without a proportionate increase in weight.

The length-weight regression equations for some species, e.g. M. edax and C. b. thomasi, do not vary among lakes. Regressions calculated for some stages of T. p. mexicanus, are similar among lakes, but for other stages are very different. For example, regressions for the nauplii of T. p. mexicanus, and for copepodids are very similar between Lakes 227 and Clay Lake, but those of adults and other life stage combinations are different between the two lakes. Regressions for different cyclopoid species are not generally similar to one another.

The regression equations for D. minutus are similar among lakes for immature copepodids, immature copepodids plus adults and for all stages together, but not for nauplii or adults alone. The regressions for D. oregonensis and D. siciloides are similar to each other, but different from those for D. minutus. The equations for E. lacustris differ from those of other calanoids and from lake to lake.

CLADOCERANS

Of the twelve cladoceran species in the lakes examined, Diaphanosoma birgei (D. brachyurum in Chang et al. 1980, 1981, 1983) and Bosmina longirostris occurred in all except Lake 885. In the latter lake, the only prominent cladoceran was Daphnia schoedleri. Daphnia galeata mendotae, from Lake 223 in our study, may be a mixture of D. g. mendotae and D. dubia. Chydorus sphaericus (actually a mixture of littoral chydorid species) occurred sporadically in pelagic samples from Lake 227 (Chang et al. 1980), 224 (Chang et al. 1983) and 302 (Lawrence and Holoka 1987).

Length-weight relationships

Length-weight relationships calculated for species of cladocerans from the three geographical areas are given in Table 10. The slopes of these regressions are near 3 except for Holopedium gibberum in Lakes 223 and 302 for which slopes are more variable.

A regression based on 70 D. g. mendotae of Lake 223 in 1978 including neonates, females, males, and egg or embryo-bearing females is not different from the regression for 43 females excluding neonates and egg-bearing individuals (Table 10). A regression based on 76 D. g. mendotae in Lake 223 in 1974 of mixed age, sex and reproductive status is virtually identical with the latter two. Thus, presence of eggs and males has little influence on the regression. The slopes of the regressions for this species are similar regardless of lake, but the y-intercepts for organisms from Lake 224 and Clay Lake differ from each other and from those of Lake 223.

The regressions for D. longiremis of Lake 302 and D. g. mendotae of Clay Lake are similar. The slopes of regressions for D. retrocurva of Lake 227 and Clay Lake are the same, but the y-intercepts differ. The regressions for D. retrocurva of Lake 227 and D. g. mendotae of Lake 224 are very similar to each other. The regression for D. schoedleri of Lake 885 does not resemble that for any other daphnid. The regressions for D. birgei of Lake 223 and for directly weighed D. birgei are the same. The slopes of the regressions for D. birgei from all the lakes are similar to each other and resemble those of the Daphnia species, but the y-intercepts may vary.

Regressions for B. longirostris of Lakes 224, 227 and Clay Lake and for C. sphaericus of Lake 223 are very similar. The regressions for B. longirostris of the two year classes of Lake 302 are similar, but they do not resemble any of the other regressions for this organism.

Regressions for H. gibberum are based on several different geometric formulae (Table 10). The two regressions for Lake 302 are similar and resemble that for Lake 223 organisms < 1 mm long. Regressions for Lake 223 organisms do not resemble those from Lake 227.

ROTIFERS

Dimensions, formulae and calculated dry weights of rotifers of ELA Lakes 223, 224, 227, and 302 and of Clay Lake are presented in Table 11. Keratella cochlearis from Clay Lake are estimated to be four times heavier than those taken from the ELA lakes. Otherwise, individual species vary very little in biomass from lake to lake, except for Synchaeta, Ascomorpha and Asplanchna, where the differences among lakes could be due to the presence of different species.

EGGS

The average dimensions and calculated biomass of eggs of organisms taken from several ELA lakes are given in Table 12. The eggs of rotifers weigh 25-35% of the adult body weight. Eggs of copepods are 1% or less of adult female weight. The eggs of calanoids are larger than those of cyclopoids even for equal-sized females. The eggs of cladocerans are approximately 10% of the estimated weight of mature females except for those of H. gibberum which are only about 1% of the body weight of the female.

DISCUSSION

METHODS OF DRY WEIGHT DETERMINATION

Several techniques have been used for the determination of dry weight biomass of zooplankton individuals. The first is drying and direct weighing of organisms, individually or in groups (Richman 1958; Burns 1969; Doohan and Rainbow 1971; Dumont et al. 1975; Pederson et al. 1976; Persson and Ekbohm 1980). Frequently, the organisms are measured (usually the length) before drying in order to calculate dry weight-length regressions (reviewed in Bottrell et al. 1976 and McCauley 1984) which subsequently can be used to estimate the biomass of organisms of known length. Occasionally, the dry weights of large numbers of organisms are averaged. This may be satisfactory for copepods of like life stage and sex or for rotifers but is not useful for cladocerans.

Secondly, volume of organisms may be estimated and converted to wet- or dry-weight biomass (Nauwerck 1963; Ruttner-Kolisko 1977; Bottrell et al. 1976; Pace and Orcutt 1981; Lawrence et al. 1987). Usually volume is estimated by equating the organism to a common geometric shape, the volume of which is calculated using measured axial dimensions. These weight estimates also may be regressed against length. Calculation of volume from geometric shapes had been used primarily for rotifers until it was extended to crustaceans by Pace and Orcutt (1981). In a third method, volume is measured by displacement of scale models of zooplankton individuals (Lewis 1979).

VARIATION IN INDIVIDUAL DRY WEIGHT ESTIMATES

Copepods

Our directly-obtained and calculated dry weights for species of copepods are generally within the range of values found by other workers for these organisms from other temperate North American lakes (Table 13). There are some exceptions. Our estimates for naupliar D. minutus are an order of magnitude less than those for organisms from Clear Lake, Ontario (Schindler and Noven 1971). Adult male and female D. sicilis from Lake 224 are only one-quarter and one-half the weight, respectively, of weights reported in the literature. Male and female C. b. thomasi from Lake 302 are very much smaller and lighter in weight than those from other ELA lakes and from the literature. The M. edax of Lake 885 appear to be much larger than reported elsewhere except for those found in a pond in New York State by Hall et al. (1970). The weights for D. minutus reported by Roff and Kwiatkowski (1977) are about 2 to 5 times greater than our values or those of other workers.

Cladocerans

The calculated biomass estimates of species of cladocerans from our lakes fall, with a few exceptions, within ranges found for these organisms in other North American temperate lakes (Table 14). The calculated weights for our very small B. longirostris are below the range of other published estimates for this organism, although the upper end of our range is generally similar to that of others. The lower limit of the weight range for D. retrocurva in our lakes is much lower than those for Lake Erie (Culver et al. 1985) or Lake Michigan (Hawkins and Evans 1979). The upper limit of our weight range of calculated values for D. birgei is much greater than reported ranges. Five organisms out of 408 were greater than 1.2 mm in length. If these five are omitted, the range of weight is reduced to 0.56 to 9.5 µg, closer to other published ranges.

Rotifers

Biomass of rotifers is most often calculated from geometric values but occasionally rotifers are dried and weighed. Our calculated values generally fall within the ranges of values published by other workers (Table 15). There are some exceptions. Gastopus stylifer, Kellicottia bostoniensis and K. taurocephela in ELA lakes are lighter then those in other lakes. Keratella hiemalis and Trichocerca cylindrica in ELA lakes are much heavier than in other lakes. Rotifer biomass may be affected by the trophy of the lakes from which they are taken. Lake Erken in Sweden is described as naturally eutrophic (Nauwerck 1963) and Clay Lake in Ontario is mesotrophic (J. Rudd, Freshwater Institute, pers. comm.). The rotifers from these lakes tend to be larger than those from the oligotrophic lakes of ELA, e.g., comparison between G. stylifer and A. priodonta in Lake Erken and ELA lakes; K. cochlearis in Clay Lake and ELA lakes (Table 15).

LENGTH-WEIGHT RELATIONSHIPS

Copepods

As animals grow, weight increases approximately as the length cubed (Peters 1983). Furthermore, length-weight regressions calculated for a population of a species are expected to have a slope of about 3. The average slope of length-weight regressions for a wide variety of animal species reported by Peters (1983) is 2.83 (N = 21, S.D.= 0.81, median = 2.98, range = 2.0 to 3.45).

Several factors can cause the slope of the regression to deviate from the theoretical maximum value of 3. Nauplii and copepodids show different patterns of growth (Lawrence et al. 1987). With development, nauplii tend to elongate faster than they grow in the other two dimensions and therefore have lower regression slopes than do copepodids which tend to grow more or less proportionately in three dimensions (Table 9, Regressions 39, 40 vs 51 to 55). This is also shown in Fig. 2A vs 2B.

A second feature of copepod growth is a dramatic elongation at the metamorphosis from N6 to C1. This can be seen in Fig. 2E. As a consequence, the regression equations calculated for nauplii and copepodids together have a lower slope than for either nauplii or copepodids alone (Table 9, Regressions 106 to 108).

Figure 2C shows an increase in slope with combining of the sexes. Females and males exhibit different growth rates. The slope of the regression for combined sexes (Table 9, Regression No. 69) is greater than that for either sex (Fig. 2, C6F, C6M). The large slope of C5 (Fig. 2B) is also the result of combining females and males.

Spurious deviations from a slope of 3 occur when the length range is very small. Figure 2 shows highly variable regression slopes for individual naupliar and copepodid stages.

Therefore, to use the equations in Table 9 to calculate dry weight for organisms of known length and life stage, we recommend that either the equations for "nauplii" (Regression No. 1 to 6, and 39 to 50) and for "copepodids + adults" (Nos. 27 to 34; 89 to 105) be used. However, if organisms have only been measured and have not been identified to life stage, then the "all life stages" (No. 35 to 38; 106 to 115) may be used.

Table 16 shows the results of using various equations from Table 9 for organisms of selected lengths. For example, weight of D. minutus of Lake 223 of 0.7 mm length is calculated to be 1.098 µg using the "copepodids" regression (No. 7), 1.118 µg using the "adults" regression (No. 16), 1.086 µg using the "copepodids + adults" regression (No. 27), or 1.191 µg using "all life phases" regression (No. 35). The range of these estimates is 9% of their mean. For C. b. thomasi of Lake 223, the range of estimates using various life stage regressions for an organism of 1.0 mm length is 25% depending upon the regression equation used (Table 16).

There are differences for a species depending upon the lake for which the regression was calculated (Table 16). For example, weights of C. b. thomasi of 1.0 mm length calculated from "copepodid + adult" regressions varied from 2.2 to 2.3 µg in ELA lakes to 2.5 µg in Lake 885 and to 5.7 µg in Lake Erie.

From Table 16, the differences in body size among species are clearly seen. Tropocyclops mexicanus adults are short and lightweight, whereas E. lacustris are longer and heavier. Effects of variation in body shape among species can also be seen on weight estimates. For example, weights calculated from the "copepodid + adult" regressions for C. b. thomasi of 0.5 mm length, are lighter than E. lacustris, D. siciloides and M. edax.

Pace and Orcutt (1981) obtained a regression for D. siciloides from eutrophic Lake Oglethorpe which is virtually identical to the one we obtained for that species from hypereutrophic Lake 885. Weight estimates for C. b. thomasi copepodids of a given length from Lake Erie using the equations of Culver et al. (1985), are up to three times higher than ours. Of the equations generated by Culver et al. (1985) for copepods of Lake Erie, only that for C. vernalis resembles those formed for organisms from our lakes. Those workers usually calculated regressions for female copepodids whereas ours are based on male and female organisms.

Cladocerans

Regression equations for some cladoceran species are similar; however, not all equations for a given species are the same from lake to lake (Table 10). Organisms from Lake 224 are slightly lighter, and those of Clay Lake two times heavier, for a given length, than those of Lake 223 (Table 17).

In general, D. birgei have similar regressions to D. g. mendotae and within the common length ranges produce similar weight estimates (Table 17). Culver et al. (1985) observed similarity between these two species in a study of Lake Ontario and Lake Erie organisms. The equation for D. schoedleri of Lake 885 resembles that for organisms of Lake Danard (Hayward and Gallup 1976); the weights produced for common lengths (Table 17) are 23-27% different. The range for D. schoedleri of Lake 885 is larger on both upper and lower ends than that from Lake Danard (Hayward and Gallup 1976), although, within the common range of lengths, the weights are in general agreement (Table 17). The equation for D. schoedleri of Lake Danard more closely resembles that of D. longiremis of Lake 302. If weights are estimated for C. sphaericus, B. longirostris, D. g. mendotae and D. birgei, using the regressions reported by Culver et al. (1985), the resulting weights are up to 10 times higher than the weights we calculate for individuals of the same lengths using our regressions (Table 17).

The regressions for B. longirostris fall into four groups: Lake 223, Lake 223 impoundments, Lake 302 (which resembles that of D. g. mendotae of Clay Lake), and Lakes 224, 227 and

and Clay Lake (which resemble those of C. sphaericus of Lake 223 and small H. gibberum of Lake 227).

Equations for H. gibberum are generally different from one another. Intercomparisons of regressions for Holopedium produce weight estimates for a common series of lengths which differ by more than two times (Table 17). Equations produced by Yan and Mackie (1987) for this species resemble those for Lake 223 organisms (using formula E, Table 2, for weight calculations). However, as seen in Table 17, the weight estimates for individuals of a given length vary greatly depending upon the length-weight regression used. Yan and Mackie (1987) have shown that simple length-weight regressions can predict the weights of Holopedium on a lake-to-lake basis, but that consideration of clutch size and a body fat index significantly improved estimates of dry weight.

FACTORS AFFECTING DRY WEIGHT OF INDIVIDUALS

Adult C. b. thomasi of six lakes provide an example of large variation in average dimensions and dry weight with life stage within a single species (Table 7). Part of this variation is the result of seasonal variation as seen in C. b. thomasi from Lake 223 (Table 8) and from Lake Michigan (Hawkins and Evans 1979). According to Warren et al. (1986), seasonal change in copepod size is governed primarily by temperature, and secondly by seasonal predation by young-of-the-year fish. Reed and Aronson (1989) also found that total lengths of copepodids of C. b. thomasi varied with water temperature. Diaptomus minutus males and females of Lake 223 undergo a less pronounced variation in size with season (Table 8). As Hawkins and Evans (1979) found in Lake Michigan organisms, weight is high in early spring and late fall, and low in summer.

There are also lake to lake differences not attributable to season. Samples of C. b. thomasi from both Lakes 302 and 885 were taken in late spring but are very different in mean size and weight. Lake trophy may be a factor. Lake 302 is oligotrophic, and Lake 885 is hypereutrophic. Carter et al. (1983) reported an influence on body length of adult female D. minutus of Secchi depth and true water colour of the lake water. They hypothesized that less transparent waters provide a measure of protection against visually feeding fish predators, thereby favouring slightly larger adults.

Lake trophy and manipulation affect the weight per unit length of cladocerans (Table 17). The B. longirostris of 0.4 mm length from experimentally eutrophied Lake 227, and mesotrophic Clay Lake are about twice as heavy as those of oligotrophic Lakes 223 and 302. Organisms obtained from an impoundment in Lake 223 are about 50% heavier than those taken from the open lake at the same time. The D. g. mendotae in mesotrophic Clay Lake are about two times heavier than those found in oligotrophic ELA lakes. The same trend is seen in H. gibberum of oligotrophic Lake 223 and eutrophic Lake 227.

In summary, though we do not understand well the basis of body size variation in organisms within and between lakes, several factors can be invoked, e.g., climate, food source, predation, competition, season and lake morphometry and trophy. As well there may be genetic variation in life history parameters. Wyngaard (1986) has reported that there is a genetic component in the variation in body size of M. edax from two geographical locations.

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REFERENCES

ARMSTRONG, F.A.J., and A.L. HAMILTON. 1973. Pathways of mercury in a polluted northwestern Ontario lake, p. 131-156. In P.C. Singer (ed.) Trace metals and metal-organic interactions in natural waters. Ann Arbor Science Publishers, Ann Arbor, MI.

ARMSTRONG, F.A.J., and D.W. SCHINDLER. 1971. Preliminary chemical characterization of waters in the Experimental Lakes Areas, northwestern Ontario. J. Fish Res. Board Can. 28: 171-187.

BARICA, J. 1975. Geochemistry and nutrient regime of saline eutrophic lakes in the Erickson-Elphinstone District of southwestern Manitoba. Can. Fish. Mar. Serv. Tech. Rep. 511: 82 p.

BERMAN, T., U. POLLINGHER, and M. GOPHEN. 1972. Lake Kinneret: planktonic populations during seasons of high and low phosphorus availability. Int. ver. theor. angew. Limnol. Verh. 18: 588-598.

BIRD, D.F., and Y.T. PRAIRIE. 1985. Practical zooplankton length-weight regression equations. J. Plank. Res. 7: 955-960.

BOTTRELL, H.H., A. DUNCAN, Z.M. GLIWICZ, E. GRYGIEREK, A. HERZIG, A. HILLBRICHT-ILKOWSKA, H. KURASAWA, P. LARSSON, and T. WEGLENSKA. 1976. A review of some problems in zooplankton production studies. Norw. J. Zool. 24: 419-456.

BRUNSKILL, G.J., and D.W. SCHINDLER. 1971. Geography and bathymetry of selected lake basins, Experimental Lakes Area, northwestern Ontario. J. Fish. Res. Board Can. 28: 139-155.

BURNS, C.W. 1969. Relation between filtering rate, temperature, and body size in four species of Daphnia. Limnol. Oceanogr. 14: 693-700.

CARTER, J.C.H., W.G. SPRULES, M.J. DADSWELL, and J.C. ROFF. 1983. Factors governing geographical variation in body size of Diaptomus minutus (Copepoda, Calanoida). Can. J. Fish. Aquat. Sci. 40: 1303-1307.

CHANG, P.S.S., D.F. MALLEY, I.L. DELBAERE, and G. MUELLER. 1981. Species composition and seasonal abundance of zooplankton in Lake 223, Experimental Lakes Area, northwestern Ontario: before and during acidification, 1974-1979. Can. Data Rep. Fish. Aquat. Sci. 290: iv + 42 p.

CHANG, P.S.S., D.F. MALLEY, W.J. FINDLAY, G. MUELLER, and R.T. BARNES. 1980. Species composition and seasonal abundance of zooplankton in Lake 227, Experimental Lakes Area, northwestern Ontario, 1969-1978. Can. Data Rep. Fish. Aquat. Sci. 182: iv + 101 p.

CHANG, P.S.S., D.F. MALLEY, W.J. FINDLAY, and G. MUELLER. 1983. Species composition and seasonal abundance of zooplankton in Lake 224, Experimental Lakes Area, northwestern Ontario, 1974-1978. Can. Manuscr. Rep. Fish. Aquat. Sci. 1720: iv + 51 p.

CHENGALATH, R., C.H. FERNANDO, and M.G. GEORGE. 1971. The planktonic Rotifera of Ontario with keys to genera and species. Univ. Waterloo Biol. Ser. 2: 40 p.

CLEUGH, T.R., and B.W. HAUSER. 1971. Results of the initial survey of the Experimental Lakes Area, northwestern Ontario. J. Fish. Res. Board Can. 28: 129-137.

COMITA, G.W. 1972. The seasonal zooplankton cycles, production and transformations of energy in Severson Lake, Minnesota. Arch. Hydrobiol. 70: 14-66.

COMITA, G.W., and S.J. McNETT. 1976. The postembryonic developmental instars of Diaptomus oregonensis Lilljeborg, 1889 (Copepoda). Crustaceana 30: 123-163.

CRUIKSHANK, D.R. 1984. Whole lake chemical additions in the Experimental Lakes Area, 1969-1983. Can. Data Rep. Fish. Aquat. Sci. 449: iv + 23 p.

CULVER, D.A., M.M. BOUCHERLE, D.J. BEAN, and J.W. FLETCHER. 1985. Biomass of freshwater crustacean zooplankton from length-weight regressions. Can. J. Fish. Aquat. Sci. 42: 1380-1390.

DOOHAN, M. 1973. Energetics of plankton rotifers applied to populations in reservoirs. Ph.D. thesis, Univ. London, London, England. 226 p.

DOOHAN, M., and V. RAINBOW. 1971. Determination of dry weights of small Aschelminthes. Oecologia 6: 380-383.

DUMONT, H.J., I. VAN DE VELDE, and S. DUMONT. 1975. The dry weight estimate of biomass in a selection of Cladocera, Copepoda and Rotifera from the plankton, periphyton and benthos of continental waters. Oecologia 19: 75-97.

FEE, E.J., D. HAYWARD, and J.A. SHEARER. 1982. Annual primary production in lakes of the Experimental Lakes Area, northwestern Ontario; 1976-1980 results. Can. Data Rep. Fish. Aquat. Sci. 327: iv + 33 p.

HALL, D.J., W.E. COOPER, and E.E. WERNER. 1970. An experimental approach to the production dynamics and structure of freshwater animal communities. Limnol. Oceanogr. 15: 839-928.

HANEY, J.F., and D.J. HALL. 1973. Sugar-coated Daphnia: a preservation technique for Cladocera. Limnol. Oceanogr. 18: 331-333.

HAWKINS, B.E., and M.S. EVANS. 1979. Seasonal cycles of zooplankton biomass in southeastern Lake Michigan. J. Great Lakes Res. 5: 256-263.

HAYWARD, R.S. and D.N. GALLUP. 1976. Feeding, filtering and assimilation in Daphnia schoedleri Sars as affected by environmental conditions. Arch. Hydrobiol. 77: 139-163.

HESSLEIN, R.H., W.S. BROECKER, and D.W. SCHINDLER. 1980. Fates of metal radiotracers added to a whole lake: sediment-water interactions. Can. J. Fish. Aquat. Sci. 37: 378-386.

HITCHIN, G.G., and N.D. YAN. 1983. Crustacean zooplankton communities of the Muskoka-Haliburton study lakes: methods and 1976-1979 data. Ont. Minist. Environ. Data Rep. 83/9.

LAWRENCE, S.G. 1980. The effects of acid and cadmium on impounded zooplankton in a Canadian Shield lake, p. 81-90. In J.F. Klaverkamp, S.L. Leonhard and K.E. Marshall (ed.). Proceedings of the Sixth Annual Aquatic Toxicity Workshop. Can. Tech. Rep. Fish. Aquat. Sci. 975: 291 p.

LAWRENCE, S.G., and M.H. HOLOKA. 1983. Effect of selenium on impounded zooplankton in a mercury contaminated lake, p. 83-92. In N.K. Kaushik and K.R. Solomon (ed.) Proceedings of the Eighth Annual Aquatic Toxicity Workshop. Can. Tech. Rep. Fish. Aquat. Sci. 115: 250 p.

LAWRENCE, S.G., and M.H. HOLOKA. 1987. Effects of low concentrations of cadmium on the crustacean zooplankton community of an artifically acidified lake. Can. J. Fish. Aquat. Sci. 44(Suppl. 1): 163-172.

LAWRENCE, S.G., D.F. MALLEY, W.J. FINDLAY, M.A. MacIVER, and I.L. DELBAERE. 1987. Method for estimating dry weight of freshwater planktonic crustaceans from measures of length and shape. Can. J. Fish. Aquat. Sci. 44(Suppl. 1): 264-274.

LEWIS, W.M. 1979. Zooplankton community analysis: studies on a tropical system. Springer-Verlag, New York. 163 p.

LINSEY, G.A., and J. BRAUND. 1984. Water chemistry data from Lake 223 of the Experimental Lakes Area, northwestern Ontario, 1974 to 1982. Can. Data Rep. Fish Aquat. Sci. 487: iv + 121 p.

LINSEY, G.A., J. BRAUND, M.P. STAINTON, and J. PROKOPOWICH. 1985. Water chemistry data from the north and south basins of Lake 302 in the Experimental Lakes Area, northwestern Ontario, 1968 to 1983. Can. Data Rep. Fish. Aquat. Sci. 509: iv + 307 p.

MAKAREWICZ, J.C., and G.E. LIKENS. 1979. Structure and function of the zooplankton community of Mirror Lake, New Hampshire. Ecol. Monogr. 49: 109-127.

MALLEY, D.F., and P.S.S. CHANG. 1980. Response of zooplankton in Precambrian Shield lakes to whole-lake chemical modifications causing pH change, p. 108-114. In Restoration of lakes and inland waters. U.S. Environ. Prot. Agency EPA 440/5-81-010.

MALLEY, D.F., P.S.S. CHANG, D.L. FINDLAY, and G.A. LINSEY. 1988. Extreme perturbation of the zooplankton community of a small Precambrian Shield lake by the addition of nutrients. Int. ver. theor. angew. Limnol. Verh. 23: 2237-2247.

MALLEY, D.F., D.L. FINDLAY, and P.S.S. CHANG. 1982. Ecological effects of acid precipitation on zooplankton, p. 297-327. In F.M. D'Itri (ed.) Acid precipitation. Effects on ecological systems. Ann Arbor Science Publishers, Ann Arbor, MI.

McCAULEY, E. 1984. The estimation of the abundance and biomass of zooplankton in samples, p. 228-261. In J.A. Downing and F.H. Rigler (ed.) A manual on methods for the assessment of secondary productivity in fresh waters. 2nd ed. Blackwell Scientific Publications, Oxford.

NAUWERCK, A. 1963. Die Beziehungen zwischen Zooplankton und Phytoplankton im See Erken. Symb. Bot. Ups. 17: 163 p.

PACE, M.L., and J.D. ORCUTT. 1981. The relative importance of protozoans, rotifers, and crustaceans in a freshwater zooplankton community. Limnol. Oceanogr. 26: 822-830.

PATALAS, K. 1971. Crustacean plankton communities in forty-five lakes in the Experimental Lakes Area, northwestern Ontario. J. Fish. Res. Board Can. 28: 231-244.

PEDERSON, G.L., E.B. WELCH, and A.H. LITT. 1976. Plankton secondary productivity and biomass: their relation to lake trophic state. Hydrobiologia 50: 129-144.

PERSSON, G., and G. EKBOHM. 1980. Estimation of dry weight in zooplankton populations: methods applied to crustacean populations from lakes in the Kuokkel Area, northern Sweden. Arch. Hydrobiol. 89: 225-246.

PETERS, R.H. 1983. Ecological implications of body size. Cambridge University Press, New York. 329 p.

PREPAS, E.E. 1984. Some statistical methods for the design of experiments and analysis of samples, p. 266-335. In J.A. Downing and F.H. Rigler (ed.) A manual on methods for the assessment of secondary productivity in fresh waters. 2nd ed. Blackwell Scientific Publications, Oxford.

PROKOPOWICH, J. 1979. Chemical characterization of epilimnion waters in the Experimental Lakes Area, northwestern Ontario. Can. Fish. Mar. Serv. Tech. Rep. 873: iv + 41 p.

RAMSEY, D.J. 1985. The response of plankton crustacean communities in large enclosures to experimental acidification. M.Sc. thesis, Univ. Manitoba, Winnipeg, MB. xvii + 203 p.

REED, E.B., and J.G. ARONSON. 1989. Seasonal variation in length of copepodids and adults of Diacyclops thomasi (Forbes) in two Colorado montane reservoirs (Copepoda). J. Crust. Biol. 9: 67-76.

RICHMAN, S. 1958. The transformation of energy by Daphnia pulex. Ecol. Monogr. 28: 273-291.

ROFF, J.C., and R.E. KWIATKOWSKI. 1977. Zooplankton and zoobenthos of selected northern Ontario lakes of different acidities. Can J. Zool. 55: 899-911.

RUDD, J.W.M., M.A. TURNER, B.E. TOWNSEND, A. SWICK, and A. FURUTANI. 1980. Dynamics of selenium in mercury-contaminated experimental freshwater ecosystems. Can. J. Fish. Aquat. Sci. 37: 848-857.

RUTTNER-KOLISKO, A. 1974. Plankton rotifers: biology and taxonomy (translated by G. Kolisko). Die Binnengewässer 26: 1-146.

RUTTNER-KOLISKO, A. 1977. Suggestions for biomass calculation of plankton rotifers. Ergebn. Limnol. 8: 71-76.

SALKI, A.G. 1981. The crustacean zooplankton communities of three prairie lakes subject to varying degrees of anoxia. M.Sc.

thesis, Univ. Manitoba, Winnipeg, MB. iv + 222 p.

SCHINDLER, D.W. 1971. Light, temperature, and oxygen regimes of selected lakes in the Experimental Lakes Area, northwestern Ontario. J. Fish. Res. Board Can. 28: 157-169.

SCHINDLER, D.W. 1972. Production of phytoplankton and zooplankton in Canadian shield lakes, p. 311-331. In Z. Kajak and A. Hillbricht-Ilkowska (ed.) Productivity problems of freshwaters. Proceedings of the IBP-UNESCO Symposium, Kazimierz Dolny, May 1970. Warszawa.

SCHINDLER, D.W. 1975. Whole-lake eutrophication experiments with phosphorus, nitrogen and carbon. Int. ver. theor. angew. Limnol. Verh. 19: 3221-3231.

SCHINDLER, D.W. 1980. Experimental acidification of a whole lake: a test of the oligotrophication hypothesis, p. 370-374. In Proceedings of the International Conference on the Ecological Impact of Acid Precipitation, Sandefjord, Norway, 11-14 March 1980.

SCHINDLER, D.W., F.A.J. ARMSTRONG, S.K. HOLMGREN, and G.J. BRUNSKILL. 1971. Eutrophication of Lake 227, Experimental Lakes Area, northwestern Ontario, by addition of phosphate and nitrate. J. Fish. Res. Board Can. 28: 1763-1782.

SCHINDLER, D.W., H. KLING, R.V. SCHMIDT, J. PROKOPOWICH, V.E. FROST, R.A. REID, and M. CAPEL. 1973. Eutrophication of Lake 227 by addition of phosphate and nitrate: the second, third and fourth years of enrichment 1970, 1971 and 1972. J. Fish. Res. Board Can. 30: 1415-1440.

SCHINDLER, D.W., R.W. NEWBURY, K.G. BEATY, J. PROKOPOWICH, T. RUSZCZYNSKI and J.A. DALTON. 1980a. Effects of a windstorm and forest fire on chemical losses from forested watersheds and on the quality of receiving streams. Can. J. Fish. Aquat. Sci. 37: 328-334.

SCHINDLER, D.W., and B. NOVÉN. 1971. Vertical distribution and seasonal abundance of zooplankton in two shallow lakes of the Experimental Lakes Area, northwestern Ontario. J. Fish. Res. Board Can. 28: 245-256.

SCHINDLER, D.W., T. RUSZCZYNSKI, and E.J. FEE. 1980b. Hypolimnion injection of nutrient effluents as a method for reducing eutrophication. Can. J. Fish. Aquat. Sci. 37: 320-327.

SCHINDLER, D.W., R. WAGEMANN, R.B. COOK, T. RUSZCZYNSKI, and J. PROKOPOWICH. 1980c. Experimental acidification of Lake 223, Experimental Lakes Area: background data and the first three years of acidification. Can. J. Fish. Aquat. Sci. 37: 342-354.

SHEARER, J.A., E.J. FEE, E.R. DEBRUYN and D.R. DECLERCQ. 1987. Phytoplankton primary production and light attenuation responses to the experimental acidification of a small Canadian shield lake. Can. J. Fish. Aquat. Sci. 44(Suppl. 1): 83-90.

SRISUWANTACH, V. 1978. Nutrients and phytoplankton in six lakes of southwestern Manitoba with particular reference to seasonal anoxic conditions. M.Sc. thesis, Univ. Manitoba, Winnipeg, MB. viii + 105 p.

SUNDE, L.A., and J. BARICA. 1975. Geography and lake morphometry of the aquaculture study area in the Erickson-Elphinstone district of southwestern Manitoba. Can. Fish. Mar. Serv. Tech. Rep. 510: 35 p.

WARD, H.B., and G.C. WHIPPLE. 1959. Freshwater biology. 2nd ed. W.T. Edmondson (ed.) John Wiley and Sons, Inc., New York. 1248 p.

WARREN, G.J., M.S. EVANS, D.J. JUDE, and J.C. AYERS. 1986. Seasonal variations in copepod size: effects of temperature, food abundance, and vertebrate predation. J. Plank. Res. 8: 841-853.

WILSON, J.B., and J.C. ROFF. 1973. Seasonal vertical distributions and diurnal migration patterns of Lake Ontario crustacean zooplankton. Proc. Conf. Great Lakes Res. 16: 190-203.

WYNGAARD, G.A. 1986. Genetic differentiation of life history traits in populations of Mesocyclops edax (Crustacea: Copepoda). Biol. Bull. (Woods Hole) 170: 279-295.

YAN, N.D., and G.L. MACKIE. 1987. Improved estimation of the dry weight of Holopedium gibberum (Crustacea, Cladocera) using clutch size, a body fat index, and lake water total phosphorus concentration. Can. J. Fish. Aquat. Sci. 44: 382-389.

YAN, N.D., and R. STRUS. 1980. Crustacean zooplankton communities of acidic, metal-contaminated lakes near Sudbury, Ontario. Can. J. Fish. Aquat. Sci. 37: 2282-2293.

Table 1. Physical and chemical parameters of study lakes. For ELA lakes, map coordinates and basic lake characteristics are given by Cleugh and Hauser (1971); morphometry and bathymetry for selected lakes are given by Brunskill and Schindler (1971); chemical and physical characteristics for selected lakes are described by Armstrong and Schindler (1971), Prokopowich (1979), and Schindler (1971); primary production is given in Fee et al. (1982) and experimental chemical additions to lakes are given by Cruikshank (1984).

Lake	Coordinates		Surface area (ha)	Mean depth (m)	Maximum depth (m)	Year	Conductivity (μmho cm^{-1} at 25°C) epilimnion	Primary production mean daily value (mg C m^{-2} day^{-1}) ice-free season	Treatment	References
223	49°42'N	93°42'W	27.3	7.2	14.4	1974	21-24	188	Additions of H_2SO_4 from 1976 to present	Schindler 1980 Schindler et al. 1980c Linsey and Braund 1984 Shearer et al. 1987
						1975	19-23	105		
						1978	26-31	212		
						1979		301		
						1980	30-37	337		
224	49°42'N	93°43'W	25.9	12.0	27.0	1974	16-21	117	Addition of trace amounts of radioactive metals, 1976	Hesslein et al. 1980
						1975	16-21	98		
						1976	16-21	102		
						1977	18-20	161		
226NE	49°42'N	93°45'W	8.3	5.7	14.7	1985	24-30	214	N, P + C additions from 1973 to 1980	Schindler 1975
226SW	49°42'N	93°45'W	7.8	6.3	11.6	1985	24-27	185	N + C additions from 1973 to 1980	Schindler 1975
227	49°42'N	93°42'W	5.0	4.4	10.0	1973	33-49	1063	N + P addition from 1969 to present	Schindler et al. 1971, 1973
						1974	32-50	856		
						1975	31-51	258		
						1976	35-49	522		
						1977	36-51	733		
						1978	29-49	777		
239	49°39'30"N	93°43'W	56.1	10.5	30.4	1985	31-44	118	Accidental forest fires 1974, 1980	Schindler et al. 1980a
302S	49°40'N	93°46'W	23.7	5.7	13.8	1980	21-24	295	Additions of H_2SO_4 from 1982 to present	Linsey et al. 1985
						1981	19-34	337		
						1982	22-27	287		
						1983	23-50	203		
Clay	50°03'N	93°20'W	3000	8.0	24.0	1978	100-150	50-125[a] (Spring)	Hg added to system via paper industry	Armstrong and Hamilton 1973 Rudd et al. 1980
885	50°39'N	100°10'W	2.4	1.9	3.0	1976	1835,1350 (Feb, Aug)	2488 (July)	Rainbow trout culture	Barica 1975 Sunde and Barica 1975 Srisuwantach 1978

[a] Clay Lake primary production values are estimated. J. Rudd (Freshwater Institute) classifies this lake as mesotrophic. Primary production is probably highest in late summer when filamentous blue-green algae dominate.

Table 2. Geometric figures and their formulae used to calculate volumes of zooplankters. Formulae are for organisms preserved in 4% formalin.

Shape	Formula[e]	Factor for adjustment for appendages/gape	Designation in tables following
General ellipsoid of revolution	$4/3\pi(abc)$		A
	$4/3\pi(abc)$	x 1.25	B
	$4/3\pi(abc)$	x 1.4	C
	$4/3\pi(abc)$	x 1.5	D
	$4/3\pi(abc)$	x 2	E
	$4/3\pi(abc)$	x 3	F
	$4/3\pi(abc)$	x 0.3	G
	$4/3\pi(abc)$	x 0.5	H
	$4/3\pi(abc)$	x 0.7	I
Elliptic cylinder	$\pi(lbc)$		J
Cone	$1/3\pi(lbc)$		K
Rectangular polyhedron	lwd		L

[e] a = length/2; b = width/2; c = depth/2; l = length; w = width; d = depth.

Table 3. Rotifer dry weights calculated using formulae given in this paper (Table 11) and those of Ruttner-Kolisko (1977). Both sets of calculations are based on mean lengths, widths and depths given in Table 11.

Species	weight, µg individual^{-1}	
	Ruttner-Kolisko formula[e]	This paper
Asplanchna priodonta	0.533 $4/3\pi(ab^2)$	0.525
Conochilis unicornis	0.010-0.013 $\pi(1b^2)/3$	0.021-0.028
Gastropus stylifer	0.015-0.020 $\pi(1bc)$	0.015-0.020
Kellicottia longispina	0.007-0.008 $\pi(1b^2)/3$	0.014-0.017
Keratella cochlearis	0.002-0.011 $\pi(1b^2)/6$	0.009-0.044
K. hiemalis	0.027 lwd	0.027-0.028
Polyarthra major	0.161 lwd	0.127
P. remata	0.012-0.018 lwd	0.010-0.015
P. vulgaris	0.039-0.049 lwd	0.031-0.041

e Formulae for volume of the rotiferan body from Ruttner-Kolisko (1977); appendages not included in calculations. Volumes are converted to dry weights assuming 1 mm^3 = 1 µg and dry weight is 7% wet weight (except *Asplanchna* where dry weight is 4% wet weight). Terms a,b,c,l,w,d as in Table 2.

Table 4. The effects of two preservatives on two body dimensions and calculated dry weights of cladocerans. Width, depth and weight are adjusted Y-means from analysis of covariance, using length as the X-variable. Mean lengths are compared separately by analysis of variance. P is the probability that the adjusted Y-means or means of the lengths are the same.

Treatment	N	Adjusted Y-Means			Observed Mean Length, µm
		Width, µm	Depth, µm	Weight, µg	
Daphnia retrocurva					
Lake 226 NE (all sizes: lengths 527 to 1597 µm)					
formalin	42	284.0	390.8	2.128	921.6
sugar-formalin	46	233.4	383.4	1.827	952.3
P		0.0001	0.31	0.019	0.54
Lake 226 NE (small: lengths 527 to 853 µm)[a]					
formalin	16	283.0	294.8	1.088	681.6
sugar-formalin	20	186.7	275.5	0.693	720.6
P		0.0002	0.0668	0.0007	0.16
Lake 226 NE (large: lengths 899 to 1597 µm)[a]					
formalin	26	291.3	456.2	2.917	1069.3
sugar-formalin	26	262.6	460.1	2.550	1130.6
P		0.0164	0.70	0.0103	0.16
Lake 226 SW (all sizes: lengths 574 to 1395 µm)					
formalin	45	312.9	374.3	1.963	861.4
sugar-formalin	45	222.7	370.3	1.494	882.4
P		<0.0000	0.58	0.0001	0.57

[a] Subsets of Lake 226NE, all sizes.

Table 4. (cont'd.)

Treatment	N	Adjusted Y-Means: Width, µm	Depth, µm	Weight, µg	Observed Mean Length, µm
Daphnia galeata mendotae					
Lake 239 (all sizes: lengths 574 to 1457 µm)					
formalin	70	442.2	491.4	4.042	964.6
sugar-formalin	82	334.8	471.0	2.950	976.3
P		<0.0001	0.0045	<0.0001	0.69
Lake 239 (small: lengths 574 to 946 µm)					
formalin	34	458.0	411.9	2.966	812.6
sugar-formalin	34	325.7	383.9	1.955	814.9
P		<0.0001	0.0081	<0.0001	0.92
Lake 239 (large: lengths 961 to 1457 µm)					
formalin	36	425.9	556.9	4.896	1108.1
sugar-formalin	48	342.1	539.8	3.776	1090.5
P		0.0004	0.071	0.0001	0.49
Diaphanosoma birgei					
Lake 226 NE,SW					
formalin	32	302.7	300.7	1.469	711.2
sugar-formalin	33	303.0	292.6	1.623	739.2
P		0.99	0.49	0.35	0.62
Lake 239					
formalin	82	262.6	298.7	1.156	743.2
sugar-formalin	84	264.1	319.5	1.213	696.7
P		0.85	<0.0001	0.26	0.0386
Bosmina longirostris					
Lake 226 NE, SW					
formalin	65	167.8	259.9	0.286	316.9
sugar-formalin	56	157.9	245.0	0.249	329.1
P		0.0186	0.0002	0.0002	0.23
Lake 239, Sample 1					
formalin	34	166.5	267.3	0.293	325.8
sugar-formalin	35	158.6	251.0	0.258	340.9
P		0.0391	0.0002	0.0002	0.22
Lake 239, Sample 2					
formalin	85	144.7	224.9	0.183	285.0
sugar-formalin	94	136.4	216.0	0.178	286.4
P		0.0008	0.0016	0.63	0.84

Table 5. Comparison of measurements and calculated dry weights (means ± S.E.) by two workers on adult female *Cyclops bicuspidatus thomasi* and on *Holopedium gibberum*.

	Length, µm	Width, µm	Depth, µm	Weight, µg individual^{-1}
Cyclops bicuspidatus thomasi, N = 10				
Worker 1	1238.0±11.7	349.1±4.6	252.8±6.2	4.014±0.187
Worker 2	1224.0±11.3	351.3±2.3	273.7±4.3	4.320±0.147
Worker 2 as % Worker 1	98.9	100.6	108.3	107.6
Difference	N.S.	N.S.	P <0.05	N.S.
Holopedium gibberum, N = 10				
Worker 1	1184.1±98.1	345.6±18.0	462.4±34.3	7.866±1.810
Worker 2	1172.0±88.1	331.2±18.3	412.8±24.9	6.460±1.199
Worker 2 as % Worker 1	99.0	95.8	89.3	82.1
Difference	N.S.	N.S.	N.S.	N.S.

Table 6. Dimensions and calculated dry weights (means ± S.E.) of life stages of of species of calanoid copepods from six lakes. Formulae are defined in Table 2. One mm^3 volume is assumed to weigh 1 mg (wet weight) and dry weight is assumed to be 7% of wet weight. N is the number of individuals measured. F and M are female and male, respectively. Length is the longest dimension along the anterior-posterior axis, width is the lateral dimension, and depth is the dorso-ventral dimension (Fig. 1). Data for organisms from Lake 223 are taken from Lawrence et al. 1987.

Species/ Life stage/ Sex	Lake	N	Length µm	Width µm	Depth µm	Formula	Dry Weight µg
Nauplius 1	223[a]	10	132.2± 0.9	69.4± 0.6	65.2± 0.8	D	0.033±0.001
	224[b]	11	145.6± 4.2	81.7± 2.0	69.7± 1.8		0.046±0.003
	227	24	131.3± 1.0	71.9± 0.7	64.0± 1.1		0.033±0.001
	302[a]	20	141.0± 1.5	72.2± 1.4	68.2± 1.6		0.039±0.002
	Clay[c]	10	132.9± 1.9	80.8± 1.4	73.0± 0.9		0.043±0.001
	885[d]	10	161.9± 2.9	84.3± 1.3	73.0± 1.0		0.055±0.002
Nauplius 2	223[a]	10	153.4± 1.9	80.2± 1.1	77.5± 1.3	D	0.053±0.002
	224[b]	10	176.0± 3.0	96.1± 1.4	80.2± 1.9		0.075±0.004
	227	29	157.2± 2.2	85.0± 0.9	77.4± 0.9		0.057±0.002
	302[a]	20	152.8± 1.9	77.4± 1.3	74.6± 1.5		0.049±0.002
	Clay[c]	10	173.1± 2.1	90.5± 1.5	85.3± 1.4		0.074±0.003
	885[d]	10	184.7± 5.7	90.4± 0.9	81.8± 1.4		0.075±0.004
Nauplius 3	223[a]	10	192.4± 2.8	93.2± 1.1	86.0± 1.0	D	0.085±0.003
	224[b]	10	213.7± 3.4	104.3± 1.7	83.9± 0.9		0.103±0.003
	227	26	189.3± 2.0	97.6± 0.8	88.3± 1.0		0.090±0.002
	302[a]	20	181.6± 2.2	88.8± 1.3	84.8± 1.1		0.075±0.002
	Clay[c]	10	201.1± 1.7	104.4± 1.0	97.0± 1.8		0.112±0.003
	885[d]	10	217.4± 4.6	102.0± 0.0	90.4± 0.9		0.110±0.003
Nauplius 4	223[a]	10	224.5± 1.1	106.2± 0.9	97.7± 1.4	D	0.128±0.002
	224[b]	11	246.9± 2.4	114.3± 1.1	98.8± 0.9		0.154±0.004
	227	24	226.0± 3.2	110.3± 1.0	98.1± 1.0		0.135±0.004
	302[a]	20	212.4± 1.9	97.2± 1.1	96.6± 2.0		0.110±0.004
	Clay[c]	10	234.6± 3.1	119.9± 1.8	107.0± 1.6		0.166±0.006
	885[d]	10	242.1± 4.0	109.4± 0.9	95.9± 1.0		0.140±0.004
Nauplius 5	223[a]	10	257.0± 2.6	114.2± 1.2	107.6± 1.5	C	0.163±0.005
	224[b]	10	295.0± 6.3	127.4± 1.4	112.3± 1.1		0.223±0.011
	227	22	269.5± 2.8	118.0± 1.1	104.6± 0.9		0.171±0.004
	302[a]	20	246.2± 4.6	109.8± 1.4	103.0± 2.0		0.143±0.004
	Clay[c]	10	283.3± 2.2	123.8± 1.7	125.0± 2.4		0.226±0.008
	885[d]	10	278.7± 2.4	118.5± 1.4	105.0± 1.3		0.168±0.009
Nauplius 6	223[a]	10	291.5± 1.9	119.9± 1.3	123.1± 1.1	B	0.197±0.003
	224[b]	11	357.4± 6.2	141.6± 2.0	123.4± 1.3		0.287±0.010
	227	20	331.0± 8.0	128.8± 2.4	119.0± 1.3		0.237±0.015
	302[a]	20	275.4± 5.7	107.0± 1.8	105.4± 1.7		0.144±0.007
	Clay[c]	10	340.1± 6.2	137.1± 1.4	147.4± 2.5		0.316±0.014
	885[d]	3	324.0± 9.3	128.0± 0.0	119.0± 2.0		0.226±0.010

a *Diaptomus minutus*
b *Diaptomus spp*
c *D. oregonensis*
d *D. sicilioides*

Table 6. (cont'd)

Species/ Life stage/ Sex		Lake	N	Length µm	Width µm	Depth µm	Formula	Dry Weight µg
Copepodid 1		223[a]	20	415.1± 3.2	127.3± 1.3	115.5± 1.5	B	0.279±0.006
		224[b]	17	458.0±14.1	142.8± 5.3	105.0± 3.4		0.331±0.031
		224[e]	1	564	192	126		0.625
		227[a]	13	446.2± 6.0	132.4± 1.9	112.5± 2.0		0.306±0.012
		227[e]	5	481.4± 8.9	158.2± 5.5	133.2± 3.4		0.468±0.036
		302[a]	20	406.5±10.9	121.0± 3.9	105.6± 2.2		0.225±0.017
		Clay[c]	10	465.6± 4.8	152.1± 1.9	125.1± 2.5		0.407±0.015
		885[d]	1	448	144	120		0.28
Copepodid 2		223[a]	20	517.4± 2.3	138.2± 1.8	126.7± 2.0	B	0.416±0.010
		224[b]	14	584.6±19.1	163.6± 5.2	132.2± 2.8		0.596±0.046
		224[e]	3	664.0± 3.3	194.0± 1.6	154.0± 0.8		0.907±0.012
		227[a]	13	567.9± 5.5	151.2± 1.9	137.3± 1.7		0.541±0.015
		227[e]	5	681.6± 7.0	208.8± 4.4	185.4± 5.9		1.214±0.066
		302[a]	20	528.4± 6.0	150.2± 2.4	128.6± 2.0		0.470±0.015
		Clay[c]	10	613.4± 4.0	174.2± 1.4	153.9± 1.5		0.754±0.015
Copepodid 3		223[a]	30	606.1± 7.7	172.0± 2.1	151.4± 2.9	B	0.730±0.025
		224[b]	21	754.9±10.5	211.6± 3.1	170.4± 4.1		1.262±0.056
		227[a]	14	702.0± 3.7	186.4± 3.0	161.6± 2.9		0.971±0.031
		227[e]	5	844.8±32.6	258.6±12.7	236.0±10.6		2.324±0.280
		302[a]	20	636.8± 6.4	174.0± 1.9	153.0± 3.5		0.779±0.025
		Clay[c]	10	704.8± 7.2	194.9± 1.9	167.2± 1.5		1.052±0.016
		885[d]	1	736	208	176		0.99
Copepodid 4		223[a]	30	771.7±13.7	214.2± 5.3	192.2± 4.3	B	1.500±0.097
		224[b]	11	861.8±38.0	226.9±11.3	192.5± 9.6		1.836±0.238
	M	224[e]	2	1116.0±84.0	342.0± 6.0	282.0± 6.0		4.947±0.563
		227[a]	16	853.5±11.8	219.0± 1.6	194.3± 2.7		1.666±0.041
		227[e]	3	1040.0±21.2	308.0±14.4	254.0±17.1		3.768±0.517
		302[a]	20	731.4± 6.0	201.8± 3.5	181.6± 2.4		1.232±0.038
		302[e]	7	1092.0±54.7	317.7±18.9	270.9±17.3		4.512±0.739
		Clay[c]	10	816.0± 9.8	217.9± 2.6	186.6± 2.6		1.525±0.054
Copepodid 5	F	223[a]	15	878.9±26.7	234.5± 9.0	219.4± 8.0	B	2.174±0.237
	M	223[a]	25	836.3±16.8	227.8± 5.8	211.9± 6.0		1.908±0.126
	F	224[a]	3	880.0±16.0	236.0± 8.0	206.0± 5.3		1.958±0.070
	M	224[a]	2	840.0± 8.5	228.0± 8.5	186.0± 4.2		1.637±0.114
	M	224[e]	3	1496.0±17.4	436.0±10.6	356.0± 4.0		10.645±0.412
	F	224[f]	8	1254.0±38.6	334.1± 7.0	279.0± 6.3		5.407±0.350
	M	224[f]	4	984.0±19.4	273.0± 5.0	240.0± 7.3		2.962±0.166
	F	227[a]	6	916.0±14.4	237.0± 4.8	214.8± 3.2		2.140±0.079
	M	227[a]	7	907.4± 8.3	238.4± 3.1	211.4± 5.0		2.100±0.084
	F	227[e]	2	1404.0± 8.5	390.0± 4.2	318.0± 4.2		7.982±0.241
	M	227[e]	2	1320.0±25.5	360.0± 0.0	306.0± 4.2		6.666+0.221
		302[a]	20	831.0±16.2	222.8± 4.3	202.4± 3.6		1.740±0.085
		302[e]	10	1285.6±24.2	378.4±11.5	325.6±12.6		7.359±0.593
		Clay[c]	10	982.4±14.5	254.9± 2.0	217.5± 7.1		2.504±0.117

a *Diaptomus minutus*
b *Diaptomus spp*
c *D. oregonensis*
d *D. siciloides*
e *Epischura lacustris*
f *D. sicilis*

Table 6. (cont'd)

Species/ Life stage/ Sex	Lake	N	Length µm	Width µm	Depth µm	Formula	Dry weight µg
Adult Copepodids							
Diaptomus minutus Female	223	72	945.5± 7.9	255.3± 2.5	224.7± 2.4	B	2.514±0.064
	224	7	953.1±16.7	240.0± 4.5	207.4± 3.4		2.182±0.105
	227	17	1031.3±14.9	282.4± 4.6	244.6± 3.5		3.272±0.109
	302	76	967.6± 6.3	254.5± 2.3	229.5± 1.7		2.604±0.047
	Clay	3	889.3±13.1	221.3± 4.3	210.7± 6.7		1.904±0.120
Diaptomus minutus Male	223	50	863.0± 5.6	231.0± 2.5	200.5± 2.0	B	1.822±0.040
	224	8	892.5±15.7	227.6± 3.9	198.0± 6.0		1.844±0.080
	227	22	925.6±16.8	255.4± 3.3	228.4± 3.4		2.484±0.086
	302	61	880.9± 5.5	234.3± 1.6	206.5± 1.9		1.962±0.037
	Clay	1	800	208	192		1.5
D. oregonensis Female	Clay	10	1290.8±25.5	332.0± 7.3	278.8± 5.0	B	5.518±0.298
Male		10	1136.7±17.5	284.9± 2.0	245.0± 3.2		3.642±0.107
D. sicilis Female	224	8	1428.0±39.3	372.0± 9.4	309.0±11.1	B	7.639±0.606
Male		7	1028.6±18.3	265.7± 4.1	219.9± 4.6		2.760±0.119
D. sicilloides Female	885	11	1261.3± 8.4	328.1± 3.6	291.5± 3.0	B	5.535±0.132
Male		5	1190.0±12.4	294.4± 3.1	273.0± 4.0		4.379±0.054
Epischura lacustris Female	223	10	1854.4±49.1	552.0±14.0	449.6± 6.2	B	21.277±1.277
	224	16	1721.9±45.9	470.6±10.0	381.8± 8.8		14.426±0.899
	227	20	1615.8±29.9	443.4± 7.0	374.4± 5.8		12.417±0.329
	302	9	1529.3±36.9	446.7±10.6	368.0±10.2		11.535±0.547
Epischura lacustris Male	223	10	1636.0±41.8	470.4±10.9	393.6± 7.9	B	13.979±0.754
	224	11	1675.3±38.4	452.7± 9.7	364.4±13.8		12.900±0.958
	227	15	1464.3±26.2	390.2± 4.9	330.0± 5.9		8.682±0.325
	302	16	1444.5±21.9	404.2± 6.2	339.8± 7.1		9.140±0.377

Table 7. Dimensions and calculated dry weights (means ± S.E.) of life stages of species of cyclopoid copepods from six lakes. Parameters are described in Table 6. Data for organisms from Lake 223 are taken from Lawrence et al. 1987.

Species/ Life stage/ Sex	Lake	N	Length µm	Width µm	Depth µm	Formula	Dry weight µg
Nauplius 1	223[a]	10	89.6± 2.3	49.6± 1.6	36.8± 2.4	D	0.009±0.001
	223[b]	10	110.1± 1.1	71.2± 1.7	50.7± 0.3		0.022±0.001
	224[c]	11	111.4± 1.8	68.9± 1.4	49.8± 1.3		0.021±0.001
	227[c]	13	115.5± 5.4	65.9± 3.0	56.7± 2.3		0.025±0.003
	302[c]	20	94.6± 2.0	52.0± 1.7	40.8± 1.1		0.011±0.001
	Clay[a]	10	81.1± 1.4	56.4±40.6	48.9± 1.1		0.012±0.0004
	885[b]	10	107.5± 1.1	70.0±0.0	59.1± 1.1		0.024±0.001
Nauplius 2	223[a]	10	102.4± 4.3	49.2± 2.4	49.6± 1.6	D	0.017±0.002
	223[b]	10	128.4± 1.5	84.4± 1.4	57.8± 1.2		0.035±0.001
	224[c]	11	130.4± 2.4	80.1± 2.0	60.1± 1.3		0.035±0.001
	227[c]	20	126.1± 3.0	76.3± 2.3	61.1± 1.5		0.033±0.002
	302[c]	20	109.4± 4.8	60.4± 2.3	46.4± 2.1		0.018±0.002
	Clay[a]	8	114.0± 2.4	70.9± 2.3	54.8± 1.1		0.024±0.001
	885[b]	8	126.1± 2.4	79.2± 1.7	61.5± 1.7		0.034±0.002
Nauplius 3	223[a]	10	126.4± 3.7	68.8± 2.4	64.0± 0.0	D	0.031±0.002
	223[b]	10	152.4± 1.6	94.0± 1.4	64.4± 1.5		0.051±0.002
	224[c]	10	150.9± 2.0	92.5± 1.7	68.2± 1.7		0.052±0.002
	227[c]	25	160.1± 4.9	93.6± 2.6	76.4± 2.2		0.064±0.005
	302[c]	27	119.7± 3.6	66.5± 1.9	50.5± 1.4		0.023±0.002
	Clay[a]	1	140	76	64		0.04
	885[b]	10	148.8± 2.7	89.1± 1.0	75.5± 1.5		0.055±0.002
Nauplius 4	223[a]	10	136.0± 3.6	82.6± 1.8	62.4± 1.6	D	0.039±0.002
	223[b]	10	174.2± 1.4	102.6± 1.4	74.2± 1.3		0.073±0.002
	224[c]	12	186.5± 4.3	106.7± 1.8	79.4± 1.9		0.088±0.005
	227[c]	26	175.5± 4.0	99.7± 2.0	84.5± 2.0		0.084±0.005
	302[c]	22	148.0± 4.9	73.8± 1.5	58.2± 1.9		0.036±0.003
	Clay[a]	10	145.7± 1.8	85.4± 1.0	71.8± 1.0		0.049±0.002
	885[b]	10	177.7± 1.3	103.2± 1.2	83.0± 0.0		0.084±0.001
Nauplius 5	223[a]	10	152.0± 4.3	84.8± 2.4	65.5± 1.6	C	0.044±0.003
	223[b]	10	198.1± 1.9	114.1± 1.5	81.9± 0.8		0.095±0.002
	224[c]	10	220.7± 2.8	114.0± 0.9	96.4± 1.2		0.125±0.003
	227[c]	26	221.8± 5.3	118.3± 2.5	101.3± 2.3		0.140±0.008
	302[c]	21	189.0± 6.0	100.0± 3.5	63.2± 1.3		0.062±0.004
	Clay[a]	10	169.6± 1.4	98.6± 1.0	81.6± 1.0		0.070±0.002
	885[b]	10	202.6± 1.3	112.9± 1.1	92.5± 1.2		0.109±0.002
Nauplius 6	223[a]	10	154.4± 2.4	87.0± 2.1	65.0± 0.8	B	0.040±0.002
	223[b]	10	242.2± 3.2	126.9± 1.7	89.7± 0.7		0.127±0.003
	224[c]	10	260.0± 0.8	131.2± 1.2	109.1± 0.6		0.170±0.002
	227[c]	28	250.5± 9.2	122.1± 3.4	106.6± 3.6		0.162±0.013
	302[c]	19	240.0± 8.7	110.7± 3.6	77.7± 3.6		0.100±0.010
	Clay[a]	10	198.2± 1.3	107.9± 1.3	91.8± 1.2		0.090±0.002
	885[b]	10	239.7± 1.8	120.5± 1.1	105.6± 1.1		0.140±0.003

[a] *Tropocyclops prasinus mexicanus*
[b] *Cyclops bicuspidatus thomasi*
[c] Mixed species

Table 7. (cont'd)

Species/ Life stage/ Sex	Lake	N	Length µm	Width µm	Depth µm	Formula	Dry Weight µg
Copepodid 1	223[a]	10	228.8± 2.4	83.2± 4.0	68.8± 4.2	B	0.061±0.006
	223[b]	35	362.9± 6.7	139.8± 2.6	88.8± 1.7	A	0.177±0.006
	224[b]	19	419.9± 5.6	148.7± 1.4	103.6± 1.7	A	0.238±0.007
	227[a]	7	262.1± 6.5	99.6± 1.6	79.0± 1.4	B	0.095±0.004
	227[b]	10	403.9±13.2	148.7± 1.5	101.4± 4.3	A	0.225±0.015
	227[d]	3	432.0±20.8	159.3± 4.5	130.0± 2.0	D	0.491±0.022
	302[c]	21	306.7±16.3	111.6± 6.4	76.4± 6.2	B	0.145±0.025
	Clay[a]	10	308.7± 3.3	112.9± 1.1	85.3± 1.5	B	0.136±0.004
	885[b]	10	409.9± 2.8	152.5± 1.8	118.8± 2.6	A	0.273±0.010
Copepodid 2	223[a]	10	290.4± 8.4	99.5± 4.1	72.8± 2.5	B	0.098±0.009
	223[b]	32	471.1± 9.0	164.4± 2.6	110.1± 2.6	A	0.320±0.017
	224[b]	18	537.3± 7.8	175.6± 1.7	128.2± 1.4	A	0.445±0.013
	227[a]	7	310.6± 2.3	104.6± 1.3	87.4± 3.1	B	0.130±0.005
	227[b]	8	504.1±14.6	170.2± 4.2	131.6± 2.9	A	0.414±0.019
	227[d]	5	549.6± 8.8	171.6± 3.2	132.6± 3.8	D	0.688±0.032
	302[c]	19	378.4±19.1	135.2± 7.6	86.3± 4.4	B	0.230±0.040
	Clay[a]	10	362.6± 5.0	121.9± 1.6	94.6± 1.0	B	0.192±0.005
	885[b]	10	514.0± 2.5	177.6± 2.0	135.8± 1.6	A	0.455±0.009
Copepodid 3	223[a]	10	326.0± 4.6	116.4± 3.2	91.2± 4.6	B	0.158±0.010
	223[b]	34	616.6±11.5	203.5± 5.4	136.2± 4.3	A	0.653±0.035
	224[a]	1	324	117	96	B	0.17
	224[b]	17	706.6± 9.7	216.3± 2.5	153.8± 2.0	A	0.865±0.026
	227[a]	4	364.5±14.0	113.5± 4.3	100.0± 2.9	B	0.191±0.020
	227[b]	9	627.9±18.6	207.7± 3.2	155.0± 3.8	A	0.746±0.045
	227[d]	6	680.0±23.5	216.0± 8.0	161.7± 6.5	D	1.327±0.135
	302[a]	16	326.5± 8.6	111.0± 2.4	80.2± 1.1	B	0.134±0.007
	302[d]	10	632.0±26.0	215.2±11.3	151.2± 9.4	D	1.187±0.179
	302[c]	9	529.3±15.1	206.2±11.2	133.8± 6.5	B	0.684±0.076
	Clay[a]	10	404.7± 3.6	132.2± 1.6	104.6± 2.1	B	0.257±0.009
	885[b]	10	655.3±10.3	214.5± 2.3	152.1± 1.9	A	0.783±0.013
Copepodid 4	223[a]	10	371.2± 6.7	136.4± 5.4	89.6± 3.5	B	0.211±0.017
	223[b]	45	774.0±11.9	246.8± 4.2	183.2± 5.3	A	1.333±0.080
	224[a]	3	414.0± 0.0	174.1± 4.9	105.3± 4.8	B	0.257±0.006
	224[b]	17	853.8±10.4	264.6± 4.8	182.1± 2.8	A	1.520±0.063
	227[a]	5	411.2± 3.9	128.6± 2.8	115.4± 1.5	B	0.280±0.009
	227[b]	11	763.9±16.5	227.2± 5.0	178.6± 3.9	A	1.150±0.068
	227[d]	5	832.8±37.9	235.4± 8.9	191.4±15.1	D	2.120±0.338
	302[a]	18	418.7±11.0	124.2± 2.4	96.9± 2.9	B	0.233±0.013
	302[d]	10	761.2±12.2	246.4± 5.9	167.2± 7.3	D	1.743±0.128
	302[c]	16	724.2±12.1	239.0± 7.6	154.2± 4.6	B	1.253±0.098
	Clay[a]	10	460.9±11.5	142.0± 2.8	112.2± 2.4	B	0.340±0.021
	885[b]	10	805.9±16.6	240.9± 5.0	192.7± 3.9	A	1.382±0.081
Copepodid 5	223[a]	10	457.6±12.7	156.8± 4.0	123.2± 3.4	B	0.411±0.027
	223[b]	20	917.2±17.4	280.4± 8.8	211.1± 8.6	A	2.055±0.179
	224[a]	3	438.0± 3.0	146.7± 1.3	109.0± 6.1	B	0.320±0.017
F	224[b]	7	1076.6±16.7	299.1±12.3	242.9± 7.0	A	2.891±0.221
M	224[b]	8	961.5±37.6	257.3± 8.0	195.0± 3.0	A	1.776±0.108
	227[a]	6	447.5± 9.7	140.7± 5.6	109.8± 4.4	B	0.320±0.027
	227[b]	6	918.0±10.6	268.0± 5.1	194.2± 4.7	A	1.753±0.068
	227[d]	5	986.4±45.3	303.6±19.9	242.4±14.4	D	4.132±0.600
	302[a]	18	466.2±12.9	146.7± 3.9	110.0± 5.0	B	0.357±0.029
	302[d]	19	969.7±36.9	298.3±14.9	224.2± 9.4	D	3.788±0.372
	302[c]	11	746.9± 8.9	221.5± 6.0	171.6± 8.3	B	1.321±0.108
	Clay[a]	10	488.5±10.0	149.2± 4.9	117.9± 3.6	B	0.400±0.033

[a] Tropocyclops prasinus mexicanus
[b] Cyclops bicuspidatus thomasi
[c] Mixed species
[d] Mesocyclops edax

Table 7. (cont'd)

Species/ Life stage/ Sex	Lake	N	Length µm	Width µm	Depth µm	Formula	Dry Weight µg
Adult Copepodids							
Cyclops	223	20	1027.6±35.2	331.2±14.5	212.1±10.4	A	2.918±0.334
bicuspidatus	224	18	1199.3± 8.4	372.0± 3.7	277.7± 4.2		4.555±0.122
thomasi	227	14	1231.0±17.4	383.1± 6.6	270.9± 6.9		4.698±0.183
Female	302	28	713.6±10.2	223.9± 4.3	146.9± 3.5		0.871±0.040
	Clay	10	1065.5±40.3	319.9±12.5	244.4± 9.4		3.172±0.396
	885	11	1094.8±12.0	353.3± 3.8	279.4± 3.9		3.967±0.122
Cyclops	223	15	884.7±22.7	239.0± 6.1	149.9± 4.1	A	1.193±0.084
bicuspidatus	224	11	1000.4± 5.2	244.6± 1.8	178.9± 3.8		1.604±0.034
thomasi	227	15	925.6±11.3	254.3± 6.3	185.6± 5.7		1.608±0.092
Male	302	10	664.0± 9.0	207.2± 2.4	114.0± 2.4		0.578±0.025
	Clay	10	880.0±11.4	225.3± 4.2	160.4± 2.7		1.165±0.030
	885	9	894.0± 8.9	233.8± 4.5	168.7± 3.6		1.294±0.048
Cyclops	302	39	1122.2±14.9	403.9± 6.8	252.1± 5.9	B	5.359±0.250
vernalis	Clay	13	1173.3±35.0	433.2±12.2	284.2±11.5		6.825±0.608
Female	885	1	1302	460	384		10.5
Cyclops	302	39	791.3±10.2	249.0± 3.4	160.5± 1.8	B	1.460±0.043
vernalis	Clay	13	816.0±12.1	252.0± 7.6	167.8± 4.3		1.604±0.116
Male							
Mesocyclops	223	10	1309.2±21.4	423.9± 6.2	286.4± 4.9	D	8.785±0.380
edax	227	15	1406.4±17.0	411.7± 3.9	327.5± 4.9		10.469±0.344
Female	302	29	1171.4± 8.4	371.0± 3.9	249.9± 2.7		5.972±0.099
	Clay	5	1620.8±65.4	507.6±29.5	422.4±23.0		19.553±2.848
	885	2	1614 ±17.0	648 ± 5.7	450 ±35.4		25.801±1.535
Mesocyclops	223	9	780.4±14.6	246.6± 3.1	170.2± 1.8	D	1.807±0.070
edax	227	17	855.9± 8.4	241.4± 2.2	185.6± 3.5		2.146±0.064
Male	302	32	795.0± 7.7	233.1± 1.5	165.0± 2.6		1.690±0.049
	Clay	5	1025.6± 6.6	295.2± 4.8	226.2± 2.5		3.768±0.118
	885	1	1094	400	320		7.7
Tropocyclops	223	30	542.1± 5.2	172.5± 1.2	132.5± 1.5	B	0.571±0.014
mexicanus	224	10	517.9±10.8	162.3± 3.2	111.9± 2.1		0.434±0.022
prasinus	227	14	542.8±10.4	179.0± 4.7	129.1± 2.8		0.579±0.029
Female	302	57	508.4± 3.0	168.2± 1.0	116.7± 2.9		0.457±0.014
	Clay	10	609.0± 7.1	192.7± 1.6	154.9± 2.4		0.834±0.023
Tropocyclops	223	30	455.7± 4.9	133.5± 0.6	98.5± 1.7	B	0.276±0.007
prasinus	224	4	441.0±13.2	133.0± 3.5	96.8± 0.8		0.261±0.014
mexicanus	227	16	463.0± 8.0	133.8± 1.7	106.7± 1.0		0.303±0.007
Male	302	48	423.1± 2.8	126.9± 1.0	92.2± 1.8		0.228±0.006
	Clay	10	484.2± 5.5	141.0± 2.8	111.5± 1.2		0.350±0.012

Table 8. Dimensions and calculated dry weights (means ± S.E.) of Lake 223 organisms sampled from different lake strata or seasons. Copepodid, female and male are abbreviated C, F and M, respectively. N is number of individuals. Mean dry weights from two strata or two seasons were compared using one-way ANOVA. F-probability is the probability that the values are not different.

			N	Length µm	Width µm	Depth µm	Dry weight µg	F-probability
I. LAKE DEPTH STRATUM								
Diaptomus minutus								
C1	19Jun74	Epi[a]	10	403.2± 3.2	124.8±2.1	110.4± 1.6	0.254±0.005	
		Hypo[a]	9	427.0± 1.6	129.8±0.9	119.9± 1.3	0.306±0.003	<0.0001
C2	19Jun74	Epi	10	513.6± 3.7	132.8±2.4	126.4± 3.7	0.395±0.015	
		Hypo	10	521.2± 2.1	143.5±1.2	127.0± 1.8	0.436±0.010	0.0433
C3	19Jun74	Epi	10	585.6±17.7	163.2±4.6	136.0± 6.0	0.603±0.050	
		Hypo	10	616.0± 9.9	176.0±2.4	158.4± 1.6	0.788±0.022	0.0033
C4	19Jun74	Epi	10	739.2±14.5	195.2± 3.2	177.6± 3.7	1.177±0.046	
		Hypo	10	812.8±35.5	241.6±10.8	208.4± 9.7	1.946±0.223	0.0034
C5F	19Jun74	Epi	6	797.3±17.2	203.7± 6.8	197.8± 6.1	1.481±0.103	
		Hypo	2	960.0± 0.0	256.0± 8.0	240.0± 0.0	2.787±0.084	0.0005
C5M	19Jun74	Epi	6	728.2±10.7	193.0± 5.9	184.8± 9.9	1.179±0.054	
		Hypo	8	884.0± 9.4	240.0± 0.0	218.0± 2.9	2.120±0.043	<0.0001
C6F	19Jun74	Epi	20	919.4±19.6	241.8± 2.4	213.6± 3.2	2.181±0.067	
		Hypo	10	928.1±22.6	254.2± 4.4	223.4± 1.9	2.417±0.081	0.0427
C6F	17Jul74	Epi	10	921.6± 9.0	233.4± 3.3	215.2± 2.2	2.123±0.054	
		Hypo	10	1011.0±12.1	295.1± 2.9	265.8± 5.3	3.632±0.085	<0.0001
C6M	19Jul74	Epi	17	833.9±11.3	220.2±3.2	201.4± 3.0	1.703±0.058	
		Hypo	3	875.0± 2.5	237.3±1.5	217.0± 3.8	2.065±0.054	0.0203
II. SEASON								
Cyclops bicuspidatus thomasi								
C6F	May74[b]	Lake	9	862.9±10.5	262.1±4.3	163.9± 4.7	1.366±0.071	
	Aug74	Lake	10	1164.1±20.5	390.7±6.7	253.1± 5.3	4.252±0.221	<0.0001
C6M	May74[b]	Lake	7	815.4±27.3	219.0±7.1	136.0± 4.9	0.907±0.098	
	Aug74	Lake	7	946.9±18.3	253.9±2.8	161.6± 2.1	1.425±0.046	0.0004
Diaptomus minutus								
C6F	May74[b]	Lake	10	943.6± 8.8	255.7± 3.4	212.2± 2.0	2.348±0.057	
	Oct74[c]	Lake	10	962.8± 5.9	262.0± 1.2	226.9± 1.8	2.913±0.091	<0.0001
C6M	May74[b]	Lake	10	894.2±6.8	243.9±1.8	204.5± 3.4	2.045±0.049	
	Oct74[c]	Lake	10	856.0±5.2	250.7±2.6	207.4± 1.9	2.407±0.058	0.0001

[a] Epi = epilimnion; Hypo = hypolimnion.

[b] Before lake temperature strata established.

[c] After fall lake turnover.

Table 9. Length-weight regressions for calanoid and cyclopoid copepods of six lakes. Equations are generated from measured lengths and calculated dry weights. The slope (b) ± the 95% confidence level (C.I.); y-intercept (lna); the average logarithm of the length, ($\overline{lnL}$); estimated variance of lnL, ($S\bar{x}^2$); correlation coefficient (r); number of observations (N); residual mean square (RMS) and range of length measurements are presented for the relationship lnw = lna + b$\overline{lnL}$, where lnw is the logarithm of the dry weight (ug). Lengths are measured as shown in Fig. 1. Formulae are defined in Table 2. Lake 223 data are taken from Lawrence et al. 1987.

Species	Regression No.	Lake	N	lna	b ± C.I.	$\overline{lnL}$	$S\bar{x}^2$	RMS	r	Range of length mm	Formula
CALANOID COPEPODS											
NAUPLII (N1-N6)											
Diaptomus minutus	1	223	60	1.2461	2.2650±0.0722	-1.6053	0.0793	0.0061	0.99	0.128-0.300	N1-4 : D
	2	302	120	0.8700	2.0669±0.1152	-1.6326	0.0623	0.0251	0.96	0.128-0.312	N5 : C
D. oregonensis	3	Clay	60	1.2249	2.1547±0.0794	-1.5284	0.0990	0.0092	0.99	0.121-0.384	N6 : B
D. siciloides	4	885	53	0.9177	2.0694±0.0996	-1.5245	0.0494	0.0063	0.99	0.144-0.339	
Mixed species	5	224	63	0.9475	2.0676±0.0656	-1.4766	0.0989	0.0066	0.99	0.121-0.393	
	6	227	145	0.9926	2.0997±0.0694	-1.6044	0.0970	0.0172	0.98	0.121-0.423	
COPEPODIDS (C1-C5)											
D. minutus	7	223	140	1.0783	2.7879±0.0875	-0.4306	0.0708	0.0196	0.98	0.384-1.120	B
	8	227	71	0.9426	2.6829±0.0802	-0.3787	0.0700	0.0079	0.99	0.405-0.960	
	9	302	100	1.0267	2.7540±0.0957	-0.4998	0.0693	0.0159	0.99	0.336-1.020	
D. oregonensis	10	Clay	50	0.9227	2.4235±0.0704	-0.3654	0.0667	0.0040	1.00	0.435-1.046	
D. siciloides	11	885[a]	8	0.8713	2.1912±0.4756	-0.6055	0.0416	0.0110	0.98	0.416-0.736	
Epischura lacustris	12	224	9	1.1839	2.9946±0.1908	-0.0422	0.1671	0.0087	1.00	0.564-1.524	
	13	227	22	0.8655	2.9373±0.1285	-0.0863	0.1079	0.0086	1.00	0.459-1.416	
	14	302[b]	17	1.1549	3.2935±0.5346	0.1806	0.0144	0.0145	0.96	0.944-1.424	
Mixed species	15	224[c]	63	0.9799	2.7765±0.0922	-0.4559	0.0706	0.0093	0.98	0.378-1.080	
ADULTS (C6)											
D. minutus	16	223	122	1.0332	2.6060±0.2797	-0.1002	0.0065	0.0157	0.86	0.728-1.104	B
	17	224	15	0.8259	1.6870±1.1410	-0.0840	0.0032	0.0125	0.66	0.840-1.032	
	18	227	39	1.0808	1.8630±0.3840	-0.0328	0.0084	0.0114	0.85	0.816-1.200	
	19	302	147	1.0174	2.5894±0.2222	-0.0757	0.0046	0.0085	0.89	0.784-1.152	
D. oregonensis	20	Clay	20	0.9717	2.7323±0.4721	0.1902	0.0074	0.0071	0.94	1.014-1.430	
D. sicilis	21	224	15	0.9311	3.0360±0.1630	0.2012	0.0326	0.0026	1.00	0.948-1.560	
D. siciloides	22	885	16	0.9608	3.1588±1.0484	0.2137	0.0012	0.0043	0.87	1.142-1.318	
E. lacustris	23	223	20	1.4670	2.4741±0.4840	0.5515	0.0120	0.0121	0.93	1.430-2.044	
	24	224	27	1.2603	2.5222±0.4337	0.5280	0.0092	0.0106	0.92	1.392-2.016	
	25	227	35	1.2702	2.4850±0.4071	0.4347	0.0085	0.0116	0.91	1.272-1.812	
	26	302	25	1.4269	2.2224±0.7181	0.3865	0.0046	0.0133	0.80	1.264-1.648	
COPEPODIDS AND ADULTS (C1-C6)											
D. minutus	27	223	262	1.0542	2.7482±0.0621	-0.2767	0.0679	0.0178	0.98	0.384-1.140	B
	28	227	110	1.0377	2.8255±0.0866	-0.2560	0.0755	0.0157	0.99	0.405-1.200	
	29	302	247	1.0282	2.7523±0.0492	-0.2474	0.0741	0.0115	0.99	0.336-1.152	
D. oregonensis	30	Clay	70	0.9772	2.5384±0.0544	-0.2066	0.1133	0.0058	1.00	0.435-1.430	
D. siciloides	31	885	24	1.0889	2.5288±0.0923	-0.0594	0.1691	0.0077	1.00	0.416-1.318	
E. lacustris	32	224	36	1.1337	2.7882±0.1161	0.3854	0.1077	0.0123	0.99	0.564-2.016	
	33	227	57	1.2014	2.6465±0.0651	0.1777	0.1624	0.0096	1.00	0.459-1.812	
	34	302[d]	42	1.2333	2.7561±0.2894	0.3031	0.0188	0.0158	0.95	0.944-1.648	
ALL LIFE PHASES (N1-C6)											
D. minutus	35	223	322	0.9212	2.1497±0.0376	-0.5243	0.3383	0.0400	0.92	0.128-1.140	B,C,D
	36	302	367	0.9059	2.1291±0.0282	-0.7003	0.4935	0.0374	0.99	0.128-1.152	
D. oregonensis	37	Clay	130	0.9212	1.9983±0.0408	-0.8167	0.5435	0.0298	0.99	0.121-1.430	
D. siciloides	38	885	77	1.0968	2.1951±0.0354	-1.0678	0.5516	0.0132	1.00	0.144-1.318	

[a] Copepodid 1-3 only.
[b] Copepodid 4-5 only.
[c] Copepodid 1-4 only.
[d] Copepodid 4-6 only.

Table 9. (cont'd)

Species	Regression No.	Lake	N	lna	b ± C.I.	$\overline{lnL}$	$S_{\overline{x}}^2$	RMS	r	Range of length mm	Formula
CYCLOPOID COPEPODS											
NAUPLII (N1-N6)											
Cyclops bicuspidatus thomasi	39	223[e]	60	-.2290	2.2520±0.1011	-1.8209	0.0716	0.0108	0.99	0.108-0.256	N1-4 : D
	40	885	58	1.3463	2.2569±0.0736	-1.8186	0.0782	0.0060	0.99	0.102-0.243	N5 : C
Mesocyclops edax	41	302[f]	15	0.8811	2.2034±0.3174	-1.6744	0.0622	0.0188	0.97	0.128-0.296	N6 : B
	42	302[g]	18	1.1897	2.3724±0.4371	-1.8500	0.0642	0.0464	0.94	0.104-0.288	
Tropocyclops prasinus mexicanus	43	223	60	1.7143	2.5762±0.2718	-2.0883	0.0491	0.0535	0.93	0.080-0.160	
	44	227	17	1.4576	2.4529±0.2128	-2.0515	0.0746	0.0119	0.99	0.085-0.198	
	45	302[f]	18	2.1369	2.8069±0.3696	-2.2164	0.0507	0.0262	0.97	0.080-0.168	
	46	302[g]	29	0.8964	2.2658±0.3697	-2.2478	0.0462	0.0420	0.92	0.076-0.176	
	47	Clay	49	1.3581	2.2981±0.0805	-1.9935	0.1033	0.0079	0.99	0.076-0.204	
Mixed species	48	224	64	1.6235	2.4594±0.0850	-1.7861	0.0897	0.0102	0.99	0.102-0.264	
	49	227	138	1.6388	2.4474±0.0780	-1.7389	0.0920	0.0196	0.98	0.085-0.315	
	50	302	129	1.0145	2.3082±0.0919	-1.9713	0.1192	0.0329	0.98	0.076-0.296	
COPEPODIDS (C1-C5)											
C. b. thomasi	51	223	166	0.9032	2.7307±0.0764	-0.5435	0.1143	0.0287	0.98	0.272-1.120	A
	52	223[e]	50	0.8601	2.5896±0.0764	-0.4756	0.0791	0.0068	0.99	0.398-0.982	
	53	224	86	0.7719	2.5549±0.0601	-0.4206	0.1049	0.0081	0.99	0.382-1.116	
	54	227	44	0.7674	2.4333±0.1330	-0.5078	0.0897	0.0167	0.98	0.315-0.960	
	55	885[c]	40	0.7924	2.3468±0.0949	-0.5498	0.0675	0.0058	0.99	0.396-0.896	
Mixed Cyclops sp.	56	302	43	1.0300	2.5050±0.2000	-0.5536	0.1165	0.0479	0.97	0.304-0.800	B
M. edax	57	227	25	1.3205	2.6629±0.2402	-0.3529	0.0847	0.0274	0.98	0.396-1.068	D
	58	302[f]	19	1.3135	2.9005±0.2094	-0.3379	0.1333	0.0234	0.99	0.412-1.184	
	59	302[g]	21	1.3506	2.7528±0.2662	-0.4170	0.1088	0.0352	0.98	0.412-1.156	
	60	302	50	1.3424	2.8027±0.1861	-0.3424	0.1015	0.0426	0.98	0.412-1.184	
T. p. mexicanus	61	223	50	1.2298	2.7965±0.2437	-1.1230	0.0591	0.0430	0.96	0.224-0.512	B
	62	224[h]	7	0.5796	2.1354±0.7518	-0.8928	0.0115	0.0059	0.96	0.324-0.441	
	63	227	29	0.7164	2.3186±0.2049	-1.0653	0.0444	0.0124	0.98	0.234-0.468	
	64	302[f]	17	0.7921	2.6362±0.3673	-1.0892	0.0728	0.0346	0.97	0.240-0.492	
	65	302[g]	22	0.8084	2.6215±0.3657	-1.1284	0.0626	0.0404	0.96	0.228-0.488	
	66	302	61	0.9578	2.7323±0.1874	-1.0086	0.0672	0.0354	0.97	0.224-0.544	
	67	Clay	50	0.7323	2.3332±0.1194	-0.9182	0.0301	0.0052	0.98	0.294-0.531	
ADULTS (C6)											
C. b. thomasi	68	223	35	0.7606	3.9145±0.3602	-0.0460	0.0238	0.0257	0.97	0.752-1.238	A
	69	223[e]	20	0.8066	4.0823±0.3991	-0.0638	0.0223	0.0173	0.98	0.752-1.238	
	70	224	29	0.4925	5.5302±0.4203	0.1126	0.0086	0.0101	0.98	0.984-1.248	
	71	227	29	0.7646	3.6183±0.4063	0.0591	0.0235	0.0258	0.96	0.828-1.344	
	72	302	38	0.9795	3.4802±0.4989	-0.3586	0.0052	0.0116	0.93	0.620-0.816	
	73	Clay	20	0.7652	3.9756±0.7528	-0.0357	0.0164	0.0400	0.93	0.800-1.302	
	74	885	20	0.8772	5.2722±0.5389	-0.0015	0.0116	0.0145	0.98	0.864-1.190	
C. vernalis	75	302	78	1.2177	3.4934±0.1661	-0.0625	0.0372	0.0199	0.98	0.696-1.360	
	76	Clay	26	1.2549	3.8299±0.2566	-0.0249	0.0401	0.0155	0.99	0.752-1.398	
M. edax	77	223	19	1.3472	3.0087±0.1490	0.0229	0.0735	0.0066	1.00	0.704-1.430	D
	78	227	32	1.2487	3.1820±0.1486	0.0763	0.0652	0.0107	0.99	0.792-1.512	
	79	302[f]	20	1.2321	3.3097±0.2783	-0.0414	0.0369	0.0123	0.99	0.776-1.216	
	80	302[g]	20	1.2758	3.1546±0.1421	-0.0477	0.0460	0.0040	1.00	0.732-1.252	
	81	302	61	1.2648	3.2053±0.1163	-0.0458	0.0404	0.0082	0.99	0.732-1.252	
T. p. mexicanus	82	223	60	1.6112	3.6336±0.2809	-0.7007	0.0110	0.0128	0.96	0.384-0.582	B
	83	224	14	0.9889	2.8054±0.4361	-0.7057	0.0096	0.0050	0.97	0.405-0.552	
	84	227	30	1.1615	2.9559±0.5726	-0.6983	0.0116	0.0263	0.89	0.405-0.594	
	85	302[f]	20	1.6122	3.4372±0.4751	-0.7802	0.0096	0.0094	0.96	0.400-0.544	
	86	302[g]	20	1.0262	3.1726±0.6524	-0.7718	0.0119	0.0218	0.92	0.392-0.524	
	87	302	105	1.5269	3.4806±0.3892	-0.7615	0.0104	0.0415	0.87	0.392-0.552	
	88	Clay	20	1.6255	3.6749±0.3068	-0.6111	0.0158	0.0064	0.98	0.448-0.659	

[c] Copepodid 1-4 only.
[e] 50 individuals (C1-C5) selected randomly (10 stage^{-1}) from 166 and 20 C6 (10 F, 10 M) selected randomly for preparation of Fig. 2.
[g] Samples taken in 1981.
[h] Samples taken in 1983.
[h] Copepodid 3-5 only.

Table 9 (cont'd)

Species	Regression No.	Lake	N	lna	b ± C.I.	$\overline{\ln L}$	$S\bar{x}^2$	RMS	r	Range of length mm	Formula
COPEPODIDS AND ADULTS (C1-C6)											
C. b. thomasi	89	223	201	0.8370	2.6608±0.0744	-0.4569	0.1341	0.0386	0.98	0.272-1.238	A
	90	223[e]	70	0.7885	2.5331±0.1264	-0.3637	0.0941	0.0293	0.98	0.398-1.238	
	91	224	115	0.8114	2.6440±0.0832	-0.2861	0.1344	0.0269	0.99	0.382-1.248	
	92	227	73	0.8344	2.5760±0.1103	-0.2826	0.1407	0.0309	0.98	0.315-1.344	
	93	885	60	0.8850	2.5440±0.1492	-0.3670	0.1163	0.0382	0.98	0.396-1.190	
M. edax	94	227	57	1.3169	2.7917±0.1240	-0.1119	0.1185	0.0254	0.99	0.396-1.512	D
	95	302[f]	39	1.2632	2.9012±0.1522	-0.1858	0.1042	0.0224	0.99	0.412-1.216	
	96	3029	41	1.3046	2.7519±0.1516	-0.2368	0.1112	0.0250	0.99	0.412-1.252	
	97	302	111	1.2931	2.8220±0.1075	-0.1794	0.0901	0.0291	0.98	0.412-1.252	
T. p. mexicanus	98	223	110	0.9246	2.5800±0.1319	-0.8927	0.0771	0.0372	0.97	0.224-0.582	D
	99	224[i]	21	0.5987	2.2153±0.3253	-0.7681	0.0178	0.0086	0.96	0.324-0.552	
	101	227	59	0.7697	2.3791±0.1538	-0.8787	0.0615	0.0210	0.97	0.234-0.594	
	102	302[e]	37	1.1881	2.9513±0.2226	-0.9222	0.0618	0.0267	0.98	0.240-0.544	
	103	302[f]	42	0.4926	2.3951±0.2363	-0.9586	0.0701	0.0393	0.96	0.228-0.524	
	104	302	166	1.0491	2.8400±0.1479	-0.8523	0.0453	0.0420	0.95	0.224-0.552	
	105	Clay	70	0.9412	2.5596±0.1226	-0.8305	0.0450	0.0117	0.98	0.294-0.659	
ALL LIFE PHASES (N1-C6)											
C. b. thomasi	106	223	261	0.6154	2.0340±0.0537	-0.7704	0.4500	0.0877	0.98	0.108-1.238	A,B,C,D
	107	223[e]	130	0.6268	1.9529±0.0437	-1.0362	0.6149	0.0434	0.99	0.108-1.238	
	108	885	118	0.7303	1.9536±0.0518	-1.0805	0.6279	0.0502	0.99	0.102-1.190	
M. edax	109	302[f]	54	1.2054	2.4404±0.0747	-0.5993	0.5440	0.0399	0.99	0.128-1.216	B,C,D
	110	3029	58	1.2484	2.4310±0.0652	-0.7201	0.6635	0.0399	1.00	0.104-1.252	
T. p. mexicanus	111	223	170	0.4774	2.0256±0.0625	-1.3146	0.3953	0.0672	0.98	0.080-0.582	B,C,D
	112	227	76	0.4804	2.0204±0.0724	-1.1410	0.3055	0.0302	0.99	0.085-0.594	
	113	302[f]	55	0.4511	2.0950±0.1102	-1.3457	0.4328	0.0705	0.98	0.080-0.544	
	114	3029	71	0.0706	1.9200±0.0801	-1.4852	0.4668	0.0526	0.98	0.076-0.524	
	115	Clay	119	0.4162	1.8636±0.0541	-1.3094	0.3987	0.0349	0.99	0.076-0.659	

[e] 50 individuals (C1 to C5) selected randomly (10 stage^{-1}) from 166 and 20 C6 (10 F, 10 M) selected randomly for preparation of Fig. 2.
[f] Samples taken in 1981.
[g] Samples taken in 1983.
[i] Copepodid 3-6 only.

Table 10. Length-weight regressions for cladocerans of six lakes. Equations are generated from measured lengths and calculated dry weights. Parameters are described in Table 9. Lengths are measured as shown in Fig. 1. Formulae are defined in Table 2.

Species	Lake	N	lna	b ± C.I.	$\overline{TAL}$	$S\bar{x}^2$	RMS	r	Ranges: Length mm	Ranges: Calculated dry weight, ug	Formula
Alona rectangula	Clay	16	2.2367	2.7418±0.4558	-1.1369	0.0341	0.0231	0.96	0.243-0.409	0.20- 1.01	A
Bosmina longirostris	223[a]	88	2.4751	3.3614±0.0946	-1.2210	0.0413	0.0083	0.99	0.204-0.492	0.05- 1.13	H
	223[b,c]	70	2.4198	2.8799±0.1916	-1.1214	0.0373	0.0237	0.96	0.204-0.486	0.11- 1.61	A
	224	12	2.9552	3.3460±0.8784	-1.1870	0.0100	0.0171	0.94	0.252-0.348	0.20- 0.64	A
	227	68	3.1104	3.3500±0.1178	-1.3275	0.0494	0.0115	0.99	0.180-0.414	0.08- 1.16	A
	302[b,d]	100	1.8747	2.9074±0.1632	-1.2140	0.0470	0.0314	0.96	0.168-0.432	0.03- 0.58	A
	302[b,e]	78	1.7930	2.7151±0.2556	-1.2543	0.0793	0.1004	0.92	0.112-0.560	0.04- 1.54	A
	Clay[b]	40	3.2245	3.4501±0.1903	-1.2444	0.0353	0.0121	0.99	0.179-0.409	0.07- 1.17	A
Ceriodaphnia lacustris	Clay	15	2.7286	3.3370±0.5188	-0.7782	0.0764	0.0617	0.97	0.275-0.704	0.20- 4.18	A
Chydorus sphaericus	223	8	3.1270	3.3678±0.2938	-1.3382	0.0109	0.0011	1.00	0.230-0.326	0.30- 0.89	A
	Clay	30	3.5035	3.2142±0.2757	-1.4548	0.0196	0.0103	0.98	0.198-0.339	0.18- 0.96	A
Daphnia											
D. catawba	223[a]	58	0.9455	3.1108±0.0976	-0.1599	0.0833	0.0113	0.99	0.560-1.542	0.41- 10.82	G
D. g. mendotae	223[a,f]	76	1.0797	2.7188±0.0870	0.2637	0.2433	0.0352	0.99	0.336-2.429	0.23- 43.11	H
	2239	70	1.0956	2.7101±0.0776	0.3799	0.1755	0.0183	0.99	0.464-2.507	0.34- 44.42	H
	2239	43	1.0649	2.7540±0.1059	0.4222	0.1267	0.0146	0.99	0.768-2.507	1.56- 44.42	H
	224	32	0.8989	2.8476±0.2294	0.4524	0.0987	0.0386	0.98	0.852-2.292	1.76- 30.57	I
	Clay[b]	31	1.7533	2.7013±0.2591	-0.2866	0.0407	0.0196	0.97	0.560-1.046	0.96- 6.77	A
D. longiremis	302	40	1.6274	3.3367±0.4511	-0.0205	0.0070	0.0136	0.93	0.816-1.104	2.52- 6.66	I
D. retrocurva	227	37	0.8637	3.1262±0.2333	-0.2154	0.0929	0.0441	0.99	0.540-1.536	0.31- 11.41	H
	Clay[b]	40	0.6323	2.7034±0.2297	-0.0230	0.0409	0.0206	0.97	0.720-1.590	0.79- 6.34	A
D. schoedleri	885[b]	86	1.3933	3.0114±0.0868	-0.0307	0.2727	0.0440	0.99	0.403-3.201	0.4 -174.4	H
Diaphanosoma birgei	223[a]	85	1.2740	3.2454±0.1908	-0.2940	0.1026	0.0800	0.96	0.390-1.318	0.07- 11.13	H
	224	10	0.9638	3.3283±0.6559	-0.2734	0.0640	0.0466	0.97	0.576-1.116	0.56- 4.95	H
	227	54	1.0720	2.9054±0.1993	-0.3344	0.0726	0.0378	0.97	0.384-1.104	0.16- 4.10	H
	302[b,d]	50	1.0436	2.7318±0.2122	-0.3224	0.1235	0.0674	0.97	0.380-1.760	0.11- 14.98	A
	302[b,e]	50	0.9740	2.6410±0.1946	-0.3452	0.0582	0.0267	0.97	0.404-1.096	0.30- 3.53	A
	Clay	159	1.0148	2.8321±0.1484	-0.5837	0.0717	0.0640	0.95	0.320-1.126	0.10- 6.47	H
	239,240,382	9[h,i]	1.1949	3.0073±0.7157	-0.2518	0.0419	0.0307	0.97	0.497-1.043		
Holopedium gibberum	223	56	2.1169	2.6977±0.0478	0.1790	0.1214	0.0038	1.00	0.512-1.967	1.37- 54.81	E
	223	56	2.1202	1.9705±0.1305	0.1790	0.1214	0.0283	0.97	0.512-1.967	2.06- 41.11	D,FJ
	223[a]	43	1.8135	2.7406±0.1080	0.3418	0.0300	0.0036	0.99	1.030-1.967	7.02- 41.11	D
	223[a]	13	2.5058	2.6426±0.2123	-0.3593	0.0421	0.0047	0.99	0.512-0.998	2.06- 9.98	F
	227	89	2.7880	3.2102±0.1362	-0.2082	0.1250	0.0515	0.96	0.324-1.440	0.74- 65.94	E
	227	89	2.8522	2.5810±0.1951	-0.2082	0.1250	0.1057	0.94	0.324-1.440	1.11- 49.46	D,FJ
	227	27	2.2752	4.5992±0.7053	0.1615	0.0104	0.0317	0.94	1.032-1.440	11.50- 49.46	D
	227	62	3.1690	3.1429±0.1963	-0.3693	0.0890	0.0523	0.97	0.324-0.984	1.11- 24.19	F
	302[d]	50	2.2852	2.4328±0.3666	-0.5098	0.0699	0.1138	0.89	0.352-1.028	0.59- 8.46	D,FJ
	302[e]	52	2.4285	2.5195±0.3396	-0.4477	0.0804	0.1169	0.90	0.320-1.128	0.28- 10.66	D,FJ

[a] Data taken from Lawrence et al. (1987).
[b] Width adjusted at measurement.
[c] Sample taken from experimental enclosure to which 30 ug·L^{-1} cadmium had been added (Lawrence 1980).
[d] 1981 samples.
[e] 1983 samples.
[f] Data taken from organisms sampled in 1974 (Lawrence et al. 1987), range of length is here corrected to 0.336-2.429 mm.
[g] Data taken from organisms sampled in 1978. Group of 70 contains females, males, neonates and egg and embryo bearing females; group of 43 contains only non-egg/embryo bearing females.
[h] Dried and weighed.
[i] 9 groups of 10-40 individuals.
[j] Depth measurement is multiplied by 3 if organism length is <1000um, by 1.5 " " " " >1000um.

Table 11. Dimensions and calculated dry weights (means ± S.E.) of rotifers from five lakes. Formulae are defined in Table 2. One mm^3 volume is assumed to weigh 1 mg (wet weight) and dry weight is assumed to be 7% of wet weight except for *Asplanchna* spp. where dry weight is calculated as 4% of wet weight. N is the number of individuals measured.

Species	Lake	N	Length µm	Width µm	Depth µm	Formula	Dry weight µg
Anuraeopsis fissa	224	7	75.6± 1.7	44.0± 1.3	44.0± 1.1	A	0.005±0.0003
	227	24	76.8± 0.9	42.9± 0.5	40.3± 0.5		0.005±0.0001
Ascomorpha ecaudis	223	10	81.6± 2.5	67.1± 1.8	66.5± 1.8	A	0.014±0.001
A. ovalis	223	10	85.3± 1.4	74.4± 0.8	53.9± 1.5	A	0.013±0.0003
Ascomorpha sp.	224	4	121.2± 2.6	78.8± 2.3	78.8± 2.3	A	0.028±0.001
	227	9	117.0± 4.2	78.4± 2.3	67.9± 2.1		0.023±0.002
Asplanchna priodonta	227	27	394.7±10.2	254.0± 5.8	239.1± 5.5	A	0.525±0.037
Asplanchna sp.	302	10	538.4±10.1	364.4± 6.5	364.4± 6.5	A	1.501±0.061
	Clay	6	303.7±26.6	243.8±12.4	228.8±11.5		0.374±0.072
Cephalodella gibba	302	10	119.2± 4.6	61.6± 1.4	81.6± 0.7	A	0.022±0.001
Cephalodella sp.	302	10	62.4± 1.3	33.2± 0.6	33.2± 0.6	A	0.003±0.0001
Colletheca sp.	223	20	76.9± 3.8	44.2± 1.8	42.7± 1.7	A	0.006±0.001
	224	9	101.0± 5.4	42.0± 2.6	42.2± 2.5		0.007±0.001
	227	13	84.1± 4.2	37.9± 1.5	36.6± 1.5		0.004±0.001
Conochilis unicornis (contracted)	223	16	89.4± 3.7	78.4± 3.7	73.5± 3.8	A	0.021±0.003
	224	13	107.9± 3.7	81.5± 3.8	78.2± 3.2		0.026±0.003
	227	27	107.7± 3.4	82.3± 2.6	80.2± 2.5		0.028±0.002
Conochiloides sp.	227	3	150.0± 6.0	97.3± 1.7	97.3± 1.7	A	0.052±0.003
Filinia longiseta	227	25	148.7± 3.2	84.2± 2.3	76.7± 2.6	A	0.037±0.003
	224	1	153	81	81		0.04
Floscularia sp.	302	15	164.3± 4.3	70.9± 1.5	70.9± 1.5	A	0.031±0.002
Gastropus hyptopus	223	10	88.9± 2.6	80.2± 1.7	73.0± 1.3	A	0.019±0.001
	224	8	86.0±+3.9	69.1± 4.6	69.1± 4.6		0.016±0.003
G. stylifer	223	20	87.8± 1.9	70.8± 1.3	44.2± 0.9	J	0.015±0.001
	227	24	97.0± 2.8	80.2± 2.9	47.3± 0.9		0.020±0.002
Hexarthra sp.	Clay	10	182.7± 5.7	138.4± 4.2	123.9± 3.2	L	0.223±0.018
Kellicottia bostoniensis	223	10	112.2± 1.1	57.0± 0.0	39.4± 1.2	B	0.012±0.0004
	224	3	117.0± 5.2	45.0± 0.0	41.0± 1.0		0.010±0.001
	227	7	114.4± 3.2	47.6± 1.7	35.3± 1.5		0.009±0.001
K. longispina	223	20	131.6± 1.1	56.2± 0.7	48.2± 0.8	B	0.016±0.0004
	224	21	130.0± 2.1	52.7± 1.3	46.8± 1.1		0.015±0.001
	227	37	122.6± 1.5	55.0± 0.7	46.2± 0.7		0.014±0.001
	Clay	10	146.1± 1.5	56.4± 0.6	47.5± 1.1		0.017±0.001

Table 11. (cont'd)

Keratella cochlearis	223	20	93.3± 0.9	53.8± 0.6	38.3± 0.3	B	0.009±0.0002
	224	15	102.5± 2.1	53.9± 1.3	42.7± 0.6		0.011±0.001
	227	31	99.0± 1.4	52.2± 0.8	44.8± 0.7		0.011±0.0004
	Clay	10	192.9±13.0	78.0± 5.6	57.1± 4.2		0.044±0.007
K. hiemalis	224	4	111.3± 2.1	64.0± 1.0	54.0± 0.0	L	0.027±0.001
	227	22	110.5± 0.9	64.1± 0.8	55.3± 0.6		0.028±0.001
K. tauro-cephala	223	14	119.3± 1.2	73.0± 0.8	47.5±1.0	A	0.015±0.0004
	224	4	112.5± 2.6	61.8± 2.8	47.3±1.3		0.012±0.001
	227	3	114.0± 3.0	75.0± 6.0	49.3±2.6		0.016±0.002
Lecane sp.	224	2	108.0± 9.0	85.5+ 4.5	44.0±1.0	L	0.028±0.0002
	227	3	96.0±13.1	78.0± 7.9	69.0±7.9		0.038±0.011
Lepadella sp.	302	10	80.8± 4.4	58.4± 3.0	28.8±1.4	A	0.005±0.001
Monommata sp.	302	10	88.4± 3.5	55.2± 1.8	55.2±1.8	A	0.010±0.001
Ploesoma lenticulare	223	20	111.4± 4.1	102.6± 3.6	102.0±3.9	A	0.046±0.004
P. truncatum	Clay	10	150.1± 3.0	119.9± 1.6	110.1±1.1	A	0.073±0.003
Ploesoma sp.	224	5	109.8± 8.7	97.2± 7.2	91.8±8.2	A	0.038±0.008
	227	9	115.0± 4.9	100.0± 4.4	98.9±3.6		0.043±0.005
Polyarthra major	Clay	10	200.6± 2.3	116.1± 2.4	98.9±1.9	J	0.127±0.005
P. remata	223	20	84.7± 1.7	52.2± 1.1	47.8±1.2	J	0.013±0.001
	224	9	81.0± 3.4	51.0± 3.4	42.9±1.7		0.010±0.002
	227	14	82.3± 3.0	56.9± 3.0	55.1±2.8		0.015±0.002
	Clay	10	80.8± 2.9	54.0± 1.7	51.6±1.5		0.013±0.001
P. vulgaris	223	20	120.3± 2.2	71.4± 1.9	65.0±1.5	J	0.031±0.002
	224	19	123.2±13.1	72.9± 2.6	62.6±2.6		0.032±0.003
	227	48	126.8± 1.5	77.1± 2.6	71.2±1.5		0.041±0.002
	Clay	10	109.8± 1.8	74.2± 0.9	70.0±0.9		0.031±0.001
Synchaeta sp.	223	10	74.3± 1.4	70.0± 0.9	65.7±1.4	A	0.013±0.001
	227	27	193.1± 7.2	145.7± 5.1	139.0±4.7		0.156±0.015
	302	10	156.0± 4.4	109.6± 3.0	109.6±3.0		0.070±0.006
	Clay	10	283.7±13.5	184.1± 1.9	191.2±2.0		0.366±0.019
Testudinella parva	302	10	102.0± 1.7	87.2± 3.5	30.8±0.9	J	0.015±0.001
Trichocerca cylindrica	223	10	318.5± 5.4	73.8± 1.7	81.0±2.6	A	0.070±0.004
	224	6	368.2±13.4	80.2± 2.5	86.5±1.4		0.094±0.006
	227	12	314.2+13.8	78.2± 3.3	78.2±3.3		0.074±0.008
	Clay	10	313.4± 6.8	78.2± 1.4	77.4±0.9		0.070±0.003
T. multi-crinis	Clay	10	208.1± 1.5	99.6± 1.0	92.5±1.2	A	0.070±0.002
Trichocerca sp. (small)	223	10	95.8± 1.9	41.1± 0.9	38.6±0.6	A	0.006±0.0003
	224	3	90.0± 0.0	34.7± 1.3	34.7±1.3	A	0.004±0.0002
	227	5	94.4± 2.0	41.2± 1.7	41.2±1.7	A	0.006±0.001
	302	10	97.6± 2.5	32.4± 0.4	32.4±0.4	A	0.004±0.0002
	Clay	10	92.0± 1.5	41.9± 0.9	42.2±0.9	K	0.006±0.0003

Table 12. Dimensions and calculated dry weights (means ± S.E.) of eggs of copepods, cladocerans and rotifers from several lakes in ELA. The formulae used to calculate volume was $4/3\pi(abc)$ where symbols are as in Table 2. One mm^3 volume is assumed to weigh 1 mg (wet weight), and dry weight is assumed to be 7% of wet weight. N is the number of eggs measured.

Species	Lake	N	Length µm	Width µm	Depth µm	Dry weight/egg µg
COPEPODA						
Calanoid copepods						
Diaptomus minutus	223	8	113.9±1.9	110.6±2.4	111.6±1.8	0.052±0.002
D. sicilis	223	1	115	115	115	0.06
Cyclopoid copepods						
Cyclops bicuspidatus thomasi	223	26	86.5±0.9	76.4±1.0	76.8±1.2	0.019±0.001
Mesocyclops edax	223	2	121.5±6.5	96.0±0.0	92.5±3.5	0.040±0.004
	302	7	95.7±1.6	93.1±1.6	91.1±0.7	0.030±0.001
Tropocyclops prasinus mexicanus	223	6	62.2+1.7	56.7±0.6	54.5±1.2	0.007±0.0004
CLADOCERA						
Bosmina longirostris	223	5	134.2±3.5	97.2±1.2	93.2±1.7	0.045±0.002
Daphnia galeata mendotae	223	6	241.2±4.9	195.2± 4.5	190.0±2.0	0.329±0.019
D. longiremis	302	10	192.5±2.1	127.7±1.7	127.7±1.7	0.115±0.004
Diaphanosoma birgei	223	1	256	121	102	0.12
Holopedium gibberum	223	5	155.8±1.7	155.8±1.7	155.8±1.7	0.139±0.005
	302	4	149.5±7.3	149.5±7.3	149.5±7.3	0.125±0.018
ROTIFERA						
Anuraeopsis fissa	227	10	58.2±2.1	34.1±0.8	33.3±0.9	0.002±0.0002
Colletheca sp.	223	5	42.2±0.8	27.2±1.3	25.0±0.0	0.001±0.0001
Conochilus sp.	223	1	83	51	51	0.01
Kellicottia bostoniensis	223	20	63.2±0.5	40.2±0.7	37.7±0.3	0.004±0.0001
K. longispina	223	20	84.3±1.9	45.5±0.9	43.7±0.8	0.006±0.0003
Keratella cochlearis	223	20	55.1±0.9	41.8±0.5	37.0±0.4	0.003±0.0001
K. hiemalis	223	5	70.2±0.8	55.0±1.3	49.0±1.4	0.007±0.0004
K. tauro-cephala	223	16	64±8±1.0	48.8±0.7	45.2±0.7	0.005±0.0002
Polyarthra remata	223	5	63.6±0.4	38.0±0.0	38.0±0.0	0.003±0.0002
	227	10	62.2±0.3	37.9±0.3	38.1±0.5	0.003±0.0001
P. vulgaris	223	4	83.5±4.6	50.8±2.2	49.2±1.8	0.008±0.001

Table 13. Comparisons of dry weights of individuals and eggs of copepods found in temperate North American lakes. Where the authors presented biomass as volume or wet weight, a dry weight estimate was calculated assuming assuming 1 mm^3 weighs 1 mg (wet weight) and dry weight is 7% of wet weight. * indicates weight obtained by drying and weighing of organisms. N is the number of organisms. Copepodid is designated as C.

Species	N	Dry weight µg individual^{-1}	Collection Site	Source
CALANOID COPEPODS				
Nauplii	720	0.067-0.45*	Lake Erie	Culver et al. 1985
	501	0.03-0.32	6 Lakes	This paper Table 6
		0.9* (500µm)	Lake Ontario	Wilson and Roff 1973
Immature Copepodids		0.87-1.17*	Muskoka-Haliburton Lakes, Ontario	Yan and Strus 1980
	190	0.83-3.23*	Lake Erie	Culver et al. 1985
		3.0	Cornell, NY ponds	Hall et al. 1970
		6.1*	Lake Ontario	Wilson and Roff 1973
	489	0.23-10.64	6 Lakes	This paper Table 6
Diaptomus minutus				
Adults		4.5*	Clear Lake, Ontario	Schindler and Novén 1971
		2.0-2.24*	Muskoka-Haliburton Lakes, Ontario	Yan and Strus 1980
		4.9*	Lake Ontario	Wilson and Roff 1973
Females		1.7-4.9*	Lake Michigan	Hawkins and Evans 1979
		11.95-26.9*	6 N.Ontario lakes	Roff & Kwiatkowski 1977
	120	5.0*	Lake Ontario	This paper Table A2
	102	1.97-3.55*	Lake Erie	Culver et al. 1985
	185	1.90-3.27	5 lakes	This paper Table 6
	56	1.96-3.97*	3 ELA lakes	Lawrence et al. 1987
Males		1.8-4.4*	Lake Michigan	Hawkins and Evans 1979
	142	1.5-2.48	5 ELA lakes	This paper Table 6
	105	4.0*	Lake Ontario	This paper Table A2
	15	3.0*	1 ELA lake	Lawrence et al. 1987
Immature Copepodids		1.6	Clear Lake, Ontario	Schindler and Novén 1971
		1.0-3.7[a]*	Clear Lake, Ontario	Schindler 1972
	30	1.47* (C5)	Lake Erie	Culver et al. 1985
	314	0.22-2.17	4 ELA lakes	This paper Table 6
Nauplii		0.4	Clear Lake, Ontario	Schindler and Novén 1971
		0.1-0.9[a]*	Clear Lake, Ontario	Schindler 1972
	180	0.03-0.20	2 ELA lakes	This paper Table 6
Eggs		0.07*	Clear Lake, Ontario	Schindler and Novén 1971
	8	0.052	L223	This paper Table 12
Diaptomus oregonensis				
Adults		3.55*	Muskoka-Haliburton Lakes, Ontario	Yan and Strus 1980
		9.0*	Lake Ontario	Wilson and Roff 1973
Females		3.8-10.9*	Lake Michigan	Hawkins and Evans 1979
		2.342*	Silver Lake, Minn.	Comita and McNett 1976
	31	9.9*	Lake Ontario	This paper Table A2
	104	3.84-8.66	Lake Erie	Culver et al. 1985
	10	5.52	Clay Lake, Ontario	This paper Table 6
Males		3.3-10.1*	Lake Michigan	Hawkins and Evans 1979
	31	8.6*	Lake Ontario	This paper Table A2
		3.373*	Silver Lake, Minn.	Comita and McNett 1976
	50	4.33-4.80	Lake Erie	Culver et al. 1985
	10	3.64	Clay Lake, Ontario	This paper Table 6

Table 13. (cont'd)

Species	N	Dry weight µg individual^{-1}	Collection Site	Source
Diaptomus oregonensis (cont'd)				
Immature	30	3.23* (C5)	Lake Erie	Culver et al. 1985
Copepodids	50	0.41-2.50	Clay Lake, Ontario	This paper Table 6
Diaptomus sicilis				
Adults		13.7*	Muskoka-Haliburton Lakes, Ontario	Hitchin and Yan 1983
		12.6*	Lake Ontario	Wilson and Roff 1973
Females	524	13.6*	Lake Superior	This paper Table A2
		13.4-23.0*	Lake Michigan	Hawkins and Evans 1979
	88	14.1*	Lake Ontario	This paper Table A2
	8	7.64	Lake 224	This paper Table 6
Males	359	10.9*	Lake Superior	This paper Table A2
		8.6-14.5*	Lake Michigan	Hawkins and Evans 1979
	95	10.7*	Lake Ontario	This paper Table A2
	7	2.76	Lake 224	This paper Table 6
Diaptomus siciloides				
Females	77	4.75-10.5*	Lake Erie	Culver et al. 1985
	11	5.54	Lake 885	This paper Table 6
Males	110	3.45-7.47*	Lake Erie	Culver et al. 1985
	5	4.38	Lake 885	This paper Table 6
Epischura lacustris				
Adults		15.9*	Muskoka-Haliburton Lakes, Ontario	Yan and Strus 1980
		5.9-13.9*	Lake Michigan	Hawkins and Evans 1979
Females	29	21.6*	Lake Huron/Georgian Bay	This paper Table A2
	69	23.9*	Lake Superior	This paper Table A2
	55	11.54-21.28	4 ELA lakes	This paper Table 6
	17	13.8-20.2*	2 ELA lakes	Lawrence et al. 1987
Males	6	15.2*	Lake Huron/Georgian Bay	This paper Table A2
	61	18.8*	Lake Superior	This paper Table A2
	52	8.68-13.98	4 ELA lakes	This paper Table 6
	7	11.43*	1 ELA lake	Lawrence et al. 1987
Immature	2	7.0*	Lake Superior	This paper Table A2
Copepodids		0.8-3.6*	Lake Michigan	Hawkins and Evans 1979
	48	0.47-10.64	3 ELA lakes	This paper Table 6
CYCLOPOID COPEPODS				
Nauplii		0.34*	Clear Lake, Ontario	Schindler and Novēn 1971
		0.01	Cornell, NY ponds	Hall et al. 1970
	680	0.096-0.405*	Lake Erie	Culver et al. 1985
	558	0.01-0.17	6 Lakes	This paper Table 7
Immature Copepodids		0.78-1.75*	Muskoka-Haliburton Lakes, Ontario	Yan and Strus 1980
		3.0	Cornell, NY ponds	Hall et al. 1970
(*Cyclops* spp.)		0.6-2.2*	Lake Michigan	Hawkins and Evans 1979
	663	0.06-4.13	6 Lakes	This paper Table 7

Table 13. (cont'd)

Species	N	Dry weight ug individual^{-1}	Collection Site	Source
Cyclops bicuspidatus thomasi				
Adults		4.05*	Clear Lake, Ontario	Schindler and Novén 1971
		3.24-4.6*	Muskoka-Haliburton Lakes, Ontario	Yan and Strus 1980
		3.1*	Lake Ontario	Wilson and Roff 1973
Females	194	4.9*	Lake Huron/Georgian Bay	This Paper Table A2
	39	4.1*	Lake Superior	This paper Table A2
	297	3.8*	Lake Ontario	This paper Table A2
		1.9-5.6*	Lake Michigan	Hawkins and Evans 1979
	67	3.4-4.9*	Lake Erie	Culver et al. 1985
	101	0.87-4.70	6 lakes	This paper Table 7
	90	2.75-3.52*	3 ELA lakes	Lawrence et al. 1987
Males	21	1.8*	Lake Huron/Georgian Bay	This paper Table A2
	29	2.5*	Lake Superior	This paper Table A2
	309	2.2*	Lake Ontario	This paper Table A2
		1.2-2.9*	Lake Michigan	Hawkins and Evans 1979
	70	0.58-1.61	6 lakes	This paper Table 7
	40	1.85-2.98*	2 ELA lakes	Lawrence et al. 1987
Immature Copepodids		1.52*	Clear Lake, Ontario	Schindler and Novén 1971
	115	1.4*	Lake Huron/Georgian Bay	This paper Table A2
		2.4*	Lake Ontario	Wilson and Roff 1973
	377	1.8*	Lake Superior	This paper Table A2
	323	2.2*	Lake Ontario	This paper Table A2
	127	0.97-2.95*	Lake Erie	Culver et al. 1985
	336	0.18-2.89	4 Lakes	This paper Table 7
Eggs		0.06*	Clear Lake, Ontario	Schindler and Novén 1971
	306	0.168*	Lake Erie	Culver et al. 1985
	26	0.019	Lake 223	This paper Table 12
Cyclops vernalis				
Adults		3.14*	Muskoka-Haliburton Lakes, Ontario	Yan and Strus 1980
		8.6*	Cornell, NY ponds	Hall et al. 1970
Females		4.8-6.4*	Lake Michigan	Hawkins and Evans 1979
	127	1.8-8.3*	Lake Erie	Culver et al. 1985
	53	5.4-10.5	3 Lakes	This paper Table 7
Males		2.4-2.6*	Lake Michigan	Hawkins and Evans 1979
	70	1.5-3.1*	Lake Erie	Culver et al. 1985
	52	1.5-1.6	2 Lakes	This paper Table 7
Immature Copepodids	224	0.33-1.43*	Lake Erie	Culver et al. 1985

Table 13. (contd)

Species	N	Dry weight ug individual^{-1}	Collection Site	Source
Mesocyclops edax				
Adults		6.46-10.7*	Muskoka-Haliburton Lakes, Ontario	Yan and Strus 1980
		18.0	Cornell, NY ponds	Hall et al. 1970
Females	23	8.4*	Lake Huron/Georgian Bay	This paper Table A2
	120	3.8-7.2*	Lake Erie	Culver et al. 1985
	61	5.97-25.80	5 Lakes	This paper Table 7
	39	7.33-9.92*	2 ELA lakes	Lawrence et al. 1987
Males	63	1.7-7.7	5 ELA lakes	This paper Table 7
	29	3.36*	1 ELA lake	Lawrence et al. 1987
Immature Copepodids	150	0.97-2.40*	Lake Erie	Culver et al. 1985
	63	0.49-4.13	2 ELA lakes	This paper Table 7
Eggs	300	0.175*	Lake Erie	Culver et al. 1985
	9	0.03-0.04	2 ELA lakes	This paper Table 12
Tropocyclops prasinus mexicanus				
Adults		0.47-0.87*	Muskoka-Haliburton Lakes, Ontario	Yan and Strus 1980
		1.20±0.057*	Mirror Lake, NH	Makarewicz and Likens 1979
		0.7-1.2*	Lake Michigan	Hawkins and Evans 1979
Females	121	0.43-0.83	5 ELA lakes	This paper Table 7
	45	1.0*	1 ELA lake	S.G. Lawrence, unpublished data
Males	108	0.23-0.35	5 ELA lakes	This paper Table 7
	26	0.38*	1 ELA lake	S.G. Lawrence, unpublished data
Immature		0.3-0.5*	Lake Michigan	Hawkins and Evans 1979
Copepodids	188	0.06-0.41	4 ELA lakes	This paper Table 7

[a] estimated from graphic material.

Table 14. Comparisons of dry weights of individuals of cladocerans in temperate North American lakes. * indicates weight obtained by the drying and weighing of individuals or groups of organisms. All other dry weight values were calculated from dimensional data. N is the number of organisms. Length (mm) of organisms are given in parentheses.

Species	N	Dry weight µg individual^{-1}	Collection Site	Source
Bosmina longirostris		2.0	Clear Lake, Ontario	Schindler and Novén 1971
		0.7-4.0[a]*	Clear Lake, Ontario	Schindler 1972
		0.54-0.78*	Muskoka-Haliburton Lakes, Ontario	Yan and Strus 1980
	295	1.4*	Lake Huron/Georgian Bay	This paper Table A2 Table 1
	102	2.4*	Lake Superior	This paper Table A2
		1.20 (0.26mm)	Lake Severson, MN	Comita 1972
		1.8*	Cornell, NY ponds	Hall et al. 1970
		1.17±0.088*	Mirror Lake, NH	Makarewicz and Likens 1979
		1.0-2.8[a]*	Lake Erie	Culver et al. 1985
	92	3.0*	Lake Ontario	This paper Table A2
		0.6-1.8*	Lake Michigan	Hawkins and Evans 1979
	100	0.95-1.04*	Lake 223	Lawrence et al. 1987
	456	0.03-1.54	5 lakes	This paper Table 10
Ceriodaphnia lacustris	60	1.9*	Lake Ontario	This paper Table A2
	15	0.2-4.18	Clay Lake	This paper Table 10
Chydorus sphaericus		0.59-0.9*	Muskoka-Haliburton Lakes, Ontario	Yan and Strus 1980
	7	1.1*	Lake Huron/Georgian Bay, Ontario	This paper Table A2
		2.0*	Cornell, NY ponds	Hall et al. 1970
		0.1-1.2[a]*	Lake Erie	Culver et al. 1985
		0.8-1.2*	Lake Michigan	Hawkins and Evans 1979
	38	0.18-0.96	2 lakes	This paper Table 10
Daphnia catawba		5.3*	Clear Lake, Ontario	Schindler and Novén 1971
		0.32-19.5[a]*	Mirror Lake, NH	Makarewicz and Likens 1979
	74	1.91-10.4*	Lake 223	Lawrence et al. 1987
	58	0.41-10.82	Lake 223	This paper Table 10
Daphnia galeata mendotae		10.2*	Clear Lake, Ontario	Schindler and Novén 1971
		8.76*	Muskoka-Haliburton Lakes, Ontario	Yan and Strus 1980
	45	4.0*	Lake Huron/Georgian Bay	This paper Table A2
	372	20.3*	Lake Superior	This paper Table A2
		2.5-8.9*	Lake Michigan	Hawkins and Evans 1979
	50	4.6-21.94[b]*	3 ELA lakes	Lawrence et al. 1987
	209	0.23-44.42[b]	3 lakes	This paper Table 10

Table 14. (cont'd)

Species	N	Dry weight µg individual^{-1}	Collection Site	Source
Daphnia retrocurva		3.14*	Muskoka-Haliburton Lakes, Ontario	Yan and Strus 1980
	100	4.8*	Lake Huron/Georgian Bay, Ontario	This paper Table A2
		1.6-7.5[a]*	Lake Erie	Culver et al. 1985
		3.7*	Lake Ontario	Wilson and Roff 1973
		1.2-6.5*	Lake Michigan	Hawkins and Evans 1979
	20	3.85*	Lake 240	This paper
	77	0.31-11.41	2 lakes	This paper Table 10
Daphnia schoedleri		1.4-57[a]* (0.55-2.05mm)	Lake Denard, Alberta	Hayward and Gallup 1976
	86	0.4-174.4 (0.4-3.2mm)	Lake 885	This paper Table 10
Diaphanosoma birgei	1	4.0*	Lake Huron/Georgian Bay	This paper Table A2
		7.0 [c]*	Cornell, NY ponds	Hall et al. 1970
	229	0.32-3.26*	3 ELA lakes	Lawrence et al. 1987
	408	0.07-14.98	5 lakes	This paper Table 10
Holopedium gibberum		20.0(4-71[a])*	Clear Lake, Ontario	Schindler and Novén 1971, Schindler 1972
		10.94*	Muskoka-Haliburton lakes, Ontario	Yan and Strus 1980
		2.0-9.4[a]*	Mirror Lake, NH	Makarewicz and Likens 1979
	98	14.5*	Lake Huron/Georgian Bay	This paper Table A2
	2	12.5*	Lake Ontario	This paper Table A2
	1	33.0*	Lake Superior	This paper Table A2
		1.9-10.9*	Lake Michigan	Hawkins and Evans 1979
		42.69-129.34*	5 N.Ontario lakes	Roff and Kwiatkowski 1977
	98	1.45-83.0* (0.51-2.12mm)	Plastic Lake, Ontario	Yan and Mackie 1987
	134	6.2-146.0* (0.87-2.18mm)	29 S. Ontario lakes	Yan and Mackie 1987
	79	4.5-21.47*	3 ELA lakes	Lawrence et al. 1987
	247	0.28-65.94[d]	3 ELA lakes	This paper Table 10

[a] Estimated from published graph
[b] Sample may contain *Daphnia dubia* specimens
[c] Designated as *D. brachyurum*
[d] Various formulae are used to arrive at these values (Table 10)

Table 15. Comparisons of dry weights of individuals of rotifers from various sources. Where authors presented biomass as volume or wet weight, dry weight value was calculated assuming 1 mm^3 weighs 1 mg (wet weight), and dry weight is 7% of wet weight. Where available, the number of individuals weighed and average length (mm) is given. * indicates weight was obtained by drying and weighing of organisms.

Species	N	Dry weight µg individual^{-1}	Collection Site	Source
Asplanchna priodonta[a]		1.2-12.0[a] (30-300x10^6 μ^3)	Lake Erken, Sweden	Nauwerck 1963
		8.0 (200x10^6 μ^3)	Lake Windermere, Eng.	Ruttner-Kolisko 1977
		1.5 (37.5x10^6 μ^3)	Lake Kinneret, Israel	Berman et al. 1972
	550	0.48-0.60*(11x10^6 μ^3)	Ghent, Belgium pond	Dumont et al. 1975
	54	1.6*	Lake Superior	B. Wilson (pers. comm.)
		2.0	Cornell, NY ponds	Hall et al. 1970
		0.212± 0.003*	Mirror Lake, NH	Makarewicz and Likens 1979
	27	0.525	Lake 227	This paper Table 11
Conochilus unicornis		0.028 (0.4x10^6 μ^3)	Lake Erken, Sweden	Nauwerck 1963
		0.082± 0.005	Mirror Lake, NH	Makarewicz and Likens 1979
	56	0.021-0.028	3 ELA lakes	This paper Table 11
Filinia longiseta	300	0.42-0.48*	Lake Patan, Nepal	Dumont et al. 1975
		0.028 (L=0.136 µm)	Lake Severson, MN	Comita 1972
	44	0.037	2 ELA lakes	This paper Table 11
Gastropus stylifer		0.0385 (0.55x10^6 μ^3)	Lake Erken, Sweden	Nauwerck 1963
	26	0.015-0.020	2 ELA lakes	This paper Table 11
Kellicottia bostoniensis		0.063 (0.0009mm^3)	Clear Lake, Ontario	Schindler and Novén 1971
		0.066± 0.012*	Mirror Lake, NH	Makarewicz and Likens 1979
	20	0.009-0.012	3 ELA lakes	This paper Table 11
K. longispina		0.007 (0.1x10^6 μ^3)	Lake Erken, Sweden	Nauwerck 1963
		0.0056 (0.8x10^6 μ^3)	Lake Windermere, Eng.	Ruttner-Kolisko 1977
		0.126 (0.0018 mm^3)	Clear Lake, Ontario	Schindler and Novén 1971
		0.100± 0.015*	Mirror Lake, NH	Makarewicz and Likens 1979
	88	0.014-0.017	4 lakes	This paper Table 11
Keratella cochlearis		0.0035 (0.05x10^6 μ^3)	Lake Erken, Sweden	Nauwerck 1963
		0.005 (0.070 µg wet weight)	Lake Lanao, Philippines	Lewis 1979
		0.001 (0.015x10^6 μ^3)	Lake Kinneret, Israel	Berman et al. 1972
		0.0105 (0.15x10^6 μ^3)	Lake Windermere, Eng.	Ruttner-Kolisko 1977
		0.049 (0.0007 mm^3)	Clear Lake, Ontario	Schindler and Novén 1971
	350	0.11*	Ghent, Belgium pond	Dumont et al. 1975
		0.07	Lake Suwa, Japan	Bottrell et al. 1976
		0.013 (0.108mm)	Lake Severson, MN	Comita 1972
		0.005	Cornell, NY ponds	Hall et al. 1970
		0.070± 0.008*	Mirror Lake, NH	Makarewicz and Likens 1979
	76	0.009-0.044	4 lakes	This paper Table 11

Table 15. (cont'd)

Species	N	Dry weight µg individual^{-1}	Collection Site	Source
egg		0.003 (0.046 µg wet weight)	Lake Lanao, Philippines	Lewis 1979
	20	0.003 ±0.001	Lake 223	This paper Table 12
K. hiemalis		0.0035(0.05x10^6 µ^3)	Lake Erken, Sweden	Nauwerck 1963
		0.005	Cornell, NY ponds	Hall et al. 1970
	26	0.027-0.028	2 ELA lakes	This paper Table 11
K. taurocephala		0.084 (0.0012 mm^3)	Clear Lake, Ontario	Schindler and Novén 1971
		0.096±0.007*	Mirror Lake, NH	Makarewicz and Likens 1979
	21	0.012-0.016	3 ELA lakes	This paper Table 11
Polyarthra remata		0.035 (0.5x10^6 µ^3)	Lake Erken, Sweden	Nauwerck 1963
		0.0105 (0.15x10^6 µ^3)	Lake Kinneret, Israel	Berman et al. 1972
		0.049 (0.0007 mm^3)	Clear Lake, Ontario	Schindler and Novén 1971
	77	0.012-0.015	4 lakes	This paper Table 11
P. vulgaris		0.0385 (0.55x10^6 µ^3)	Lake Erken, Sweden	Nauwerck 1963
		0.020 (0.29ug wet weight) (0.077mm)	Lake Lanao, Philippines	Lewis 1979
		0.098 (0.0014 mm^3)	Clear Lake, Ontario	Schindler and Novén 1971
		0.043*	London, Eng. reservoir	Doohan 1973
		0.060±0.002*	Mirror Lake, NH	Makarewicz and Likens 1979
	97	0.031-0.041	4 lakes	This paper Table 11
egg		0.0031 (0.044 µg wet)	Lake Lanao, Philippines	Lewis 1979
	4	0.008	Lake 223	This paper Table 12
Trichocerca cylindrica		0.007 (0.0001 mm^3)	Clear Lake, Ontario	Schindler and Novén 1971
	38	0.070-0.094	4 ELA lakes	This paper Table 11

[a] Dry weight is calculated as 4% wet weight (Dumont et al. 1975)

Table 16. Dry weights (µg individual^{-1}) calculated using regression equations for copepods of representative lengths. The regression equations used are those given in Table 9, except as noted. A dash indicates the length is outside the range of lengths on which the equation was based; a blank indicates no information is available.

Length mm	*Diaptomus minutus*					*D. oregonensis*		*D. sicilioides*			*Epischura lacustris*			
	Lake 223	224	227	302	Erie[a]	Clay	Erie[a]	885	Ogle-thorp[b]	Erie[a]	223	224	227	302
Nauplii														
0.08	-			-		-		-						
0.15	0.047			0.048		0.057		0.050						
0.25	0.151			0.138		0.172		0.143						
0.3	0.228			0.201		0.255		0.208						
Copepodids														
0.25	-		-	-		-		-				-	-	-
0.3	-		-	-		-		-				-	-	-
0.4	0.231		0.221	0.226		-		-				-	-	-
0.5	0.430		0.401	0.417		0.470		0.526				0.412	0.312	-
0.7	1.098		0.990	1.054		1.062		1.100				1.128	0.837	-
1.0	2.969		-	2.814		2.521		-				3.281	2.386	3.197
1.2	-		-	-		-		-				5.665	4.077	5.828
1.4	-		-	-		-		-				8.988	6.412	9.682
Adults														
0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.7	(1.118)[c]	-	-	(1.206)[c]	(1.869)[c]	-	-	-	-	-	-	-	-	-
1.0	2.832	2.298	2.964	2.778	-	2.651	6.197	-	2.858	5.887	-	-	-	-
1.2	-	-	4.163	-	-	4.364	8.860	4.659	4.475	11.877	-	-	-	-
1.4	-	-	-	-	-	6.650	-	-	-	-	-	8.283	8.266	8.858
2.0	-	-	-	-	-	-	-	-	-	-	24.239	20.366	-	-
Copepodids + Adults														
0.25	-		-	-		-		-	-	-	-	-	-	-
0.3	-		-	-		-		-	-	-	-	-	-	-
0.4	0.233		(0.214)[c]	0.225		-		-	-	-	-	-	-	-
0.5	0.431		0.401	0.417		0.459		0.517	0.519	-	-	-	0.534	-
0.7	1.086		1.038	1.054		1.078		1.210	1.188	-	-	1.210	1.300	-
1.0	2.895		2.845	2.812		2.665		2.982	2.858	-	-	2.982	3.341	3.460
1.2	-		4.762	-		4.233		4.729	4.475	-	-	5.198	5.413	5.718
1.4	-		-	-		6.260		-	-	-	-	6.984	8.139	8.746
2.0	-		-	-		-		-	-	-	-	17.211	-	-
All life stages														
0.08	-			-		-		-						
0.15	0.043			0.044		0.058		0.047						
0.25	0.130			0.132		0.160		0.144						
0.3	0.193			0.194		0.230		0.214						
0.4	0.358			0.358		0.409		0.403						
0.5	0.578			0.576		0.638		0.658						
0.7	1.191			1.180		1.250		1.378						
1.0	2.563			2.521		2.550		3.014						
1.2	-			-		3.671		4.498						
1.4	-			-		4.995		-						

[a] Equations of Culver et al. (1985)
[b] Equation of Pace and Orcutt (1981); no length range or RMS given
[c] Length is slightly outside of the range over which the regression was calculated

Table 16. (contd)

Length mm	Tropocyclops prasimus mexicanus							Cyclops bicuspidatus thomasi							
	Lake 223	224	227	302[d]	302[e]	302[f]	Clay	223[g]	223[h]	224	227	302	Clay	885	Erie[a]
Nauplii															
0.08	0.009		-		0.007	(0.008)[c]	(0.012)[c]	-	-					-	
0.15	0.043		0.041		0.042	0.034	0.050	0.048	0.048					0.053	
0.25	-		-		-	-	-	0.151	0.151					-	
0.3	-		-		-	-	-	-	-					-	
Copepodids															
0.25	0.072	-	0.083	0.060	0.058	0.060	-							-	
0.3	0.121	-	0.126	0.099	0.094	0.098	0.126	0.093	-	-	-			-	
0.4	0.270	0.101	0.246	0.217	0.201	0.207	0.246	0.205	0.221	0.209	0.234			0.258	
0.5	0.503	-	-	-	-	-	0.414	0.377	0.394	0.370	0.402			0.435	
0.7	-	-	-	-	-	-	-	0.945	0.941	0.873	0.912			0.959	
1.0	-	-	-	-	-	-	-	2.503	-	2.173	-			-	
1.2	-	-	-	-	-	-	-	-	-	-	-			-	
1.4	-	-	-	-	-	-	-	-	-	-	-			-	
Adults															
0.4	0.181	(0.206)[c]	(0.216)[c]	0.194	0.216	0.154	-	-	-	-	-	-	-	-	
0.5	0.406	0.386	0.417	0.421	0.465	0.313	0.399	-	-	-	-	-	-	-	
0.7	-	-	-	-	-	-	-	-	-	-	-	0.774	-	-	
1.0	-	-	-	-	-	-	-	2.167	2.143	1.645	2.176	-	2.193	2.422	
1.2	-	-	-	-	-	-	-	4.424	4.412	4.508	4.209	-	4.527	-	
1.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
2.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Copepodids + Adults															
0.25	0.072	-	0.081	0.057	0.056	0.060	-	-	-	-	-			-	-
0.3	0.115	-	0.124	0.095	0.095	0.093	0.118	0.096	-	-	-			-	-
0.4	0.242	0.240	0.247	0.216	0.223	0.186	0.247	0.206	0.225	0.202	0.221			0.240	-
0.5	0.430	0.394	0.419	0.407	0.430	0.317	0.437	0.372	0.392	0.365	0.392			0.423	-
0.7	-	-	-	-	-	-	-	0.911	0.906	0.889	0.933			0.997	2.854
1.0	-	-	-	-	-	-	-	2.354	2.203	2.282	2.339			2.470	5.690
1.2	-	-	-	-	-	-	-	3.824	3.469	3.695	3.742			-	-
1.4	-	-	-	-	-	-	-	-	-	-	-			-	-
2.0	-	-	-	-	-	-	-	-	-	-	-			-	-
All life stages															
0.08	0.010		-		0.008	0.009	0.014	-	-					-	
0.15	0.036		0.036		0.031	0.029	0.045	0.041	0.047					0.052	
0.25	0.101		0.100		0.089	0.077	0.117	0.115	0.128					0.142	
0.3	0.145		0.144		0.131	0.109	0.164	0.167	0.183					0.203	
0.4	0.261		0.258		0.239	0.190	0.280	0.300	0.321					0.355	
0.5	0.409		0.404		0.381	0.291	0.424	0.472	0.497					0.550	
0.7	-		-		-	-	-	0.936	0.959					1.060	
1.0	-		-		-	-	-	1.933	1.928					2.128	
1.2	-		-		-	-	-	2.801	2.754					-	
1.4	-		-		-	-	-	-	-					-	

[a] Equations of Culver et al. (1985)
[c] Length is slightly outside of the range over which the regression was calculated
[d] 1981 and 1983 organisms
[e] 1981 organisms
[f] 1983 organisms
[g] All available organisms used to obtain equation
[h] Equal numbers of each stage used to obtain equation

Table 16. (contd)

Length mm	C. vernalis				Mesocyclops edax				
	Lake	302	Clay	Erie[a]	223	227	302[d]	302[e]	302[f]	Erie[a]
Naupli										
0.08								-	-	
0.15								0.037	0.037	
0.25								0.115	0.125	
0 3								-	-	
Copepodids										
0.25						-	-	-	-	
0.3						-	-	-	-	
0.4						0.331		-	-	
0.5						0.600	0.505	0.504	0.583	
0.7						1.469	1.174	1.337	1.472	
1.0						3.797	2.869	3.763	3.928	
1.2						-	-	-	-	
1.4						-	-	-	-	
Adults										
0.4		-	-		-	-	-	-	-	
0.5		-	-		-	-	-	-	-	
0.7		0.982	-		1.320	-	-	-	-	
1.0		3.413	3.535		3.860	3.505	3.557	3.450	3.589	
1.2		6.453	7.106		6.680	6.260	6.381	6.307	6.379	
1.4		-	-		10.621	10.224	-	-	-	
2.0		-	-		-	-	-	-	-	
Copepodids + Adults										
0.25						-	-	-	-	-
0.3						-	-	-	-	-
0.4				0.683		0.293	-	-	-	-
0.5				1.208		0.546	0.407	0.479	0.554	-
0.7				2.855		1.396	1.351	1.271	1.399	2.383
1.0				7.106		3.780	2.916	3.577	3.733	6.692
1.2				11.324		6.288	6.185	6.070	6.165	-
1.4				-		9.669	-	-	-	-
2.0				-		-	-	-	-	-
All life stages										
0.08								-	-	
0.15								0.033	0.035	
0.25								0.116	0.122	
0.3								0.180	0.190	
0.4								0.364	0.383	
0.5								0.627	0.659	
0.7								1.426	1.494	
1.0								3.405	3.555	
1.2								5.314	5.538	
1.4								-	-	

[a] Equations of Culver et al. (1985)
[d] 1981 and 1983 organisms
[e] 1981 organisms
[f] 1983 organisms

Table 17. Dry weights (µg individual^{-1}) calculated using regression equations for cladocerans of representative lengths. Equations are listed in Table 10, except as noted. A dash indicates the length is outside the range of lengths on which the equation was based.

Length mm	*Bosmina longirostris*								*Ceriodaphnia lacustris*		*Chydorus sphaericus*		
	Lake 223[a]	223[b]	224	227	302[c]	302[d]	Clay	Erie[e]	Clay	Ontario[e]	223	Clay	Ontario[e]
0.2	0.053	0.110	-	0.103	0.061	0.080	0.098	-	-	-	-	0.189	-
0.3	0.209	0.355	0.345	0.400	0.200	0.240	0.397	1.213	0.284	-	0.396	0.697	1.299
0.4	0.548	0.813	-	1.048	0.461	0.525	1.072	2.302	0.742	0.660	-	-	-
0.5	-	-	-	-	-	0.962	-	-	1.563	1.025	-	-	-

Length mm	*Daphnia catawba*	*D. galeata mendotae*						*D. longiremis*	*D. retrocurva*		*D. schloederi*		*Diaphanosoma birgei*							
	Lake 223	223[f]	223[g]	223[h]	224	Clay	Erie[e]	302	227	Clay	Erie[e]	885	Danard[i]	223	224	227	302[c]	302[d]	Clay	ELA weighed	Erie[e]
0.4	-	0.248	-	-	-	-	-	-	-	-	0.325	-	-	0.190	-	0.208	0.240	0.239	0.213	-	1.946
0.5	-	0.455	0.461	-	-	-	2.550	-	-	-	0.592	0.511	-	0.392	-	0.397	0.442	0.430	0.400	0.417	2.458
0.8	1.293	1.633	1.649	1.580	-	3.191	5.319	-	1.207	1.040	2.086	2.103	2.729	1.803	1.277	1.557	1.596	1.489	1.514	1.715	-
1.1	3.482	3.882	3.908	3.799	3.286	-	8.754	7.044	3.266	2.460	4.898	5.486	7.198	5.070	3.685	3.927	3.810	3.452	3.731	-	-
1.4	7.373	7.479	7.513	7.381	6.530	-	12.766	-	6.942	4.722	9.349	11.096	15.003	-	-	-	7.363	-	-	-	-
1.9	-	17.156	17.188	17.113	15.579	-	20.584	-	-	-	-	27.832	38.028	-	-	-	-	-	-	-	-
2.4	-	32.379	32.374	32.565	-	-	-	-	-	-	-	57.474	-	-	-	-	-	-	-	-	-

	Holopedium gibberum											
	Lake	223[j]	223[k]	223[l]	223[m]	227[j]	227[k]	227[l]	227[m]	302[c]	302[d]	Plastic[n] Model 1	Plastic[n] Model 2
0.4	-	-	-	-	0.880	1.716	1.371	-	1.120	1.195	-	-
0.5	-	-	-	-	1.801	3.053	2.764	-	1.927	2.097	-	-
0.8	4.558	5.445	6.810	-	8.145	10.269	12.108	-	6.045	6.853	4.304	3.820
1.1	10.760	10.198	-	7.977	22.640	23.360	-	15.324	-	15.288	11.047	9.498
1.4	20.621	16.401	-	15.447	49.102	43.531	-	46.458	-	-	22.555	18.931
1.9	46.993	29.938	-	35.672	-	-	-	-	-	-	55.695	-

a N = 88, lake organisms
b N = 70, impounded organisms
c 1981 organisms
d 1983 organisms
e Equations of Culver et al. 1985 including *D. leuchtenbergianum*
f 1974 organisms
g 1978 organisms, all inclusive
h 1978 organisms, no young, male or egg bearing females
i Equation obtained from graphed data in Hayward and Gallup (1976)
b = 3.0456 lna = 1.634 RMS = 0.099
j Formulae E
k Formulae D,F
l Formula F
m Formula D
n Yan and Mackie 1987

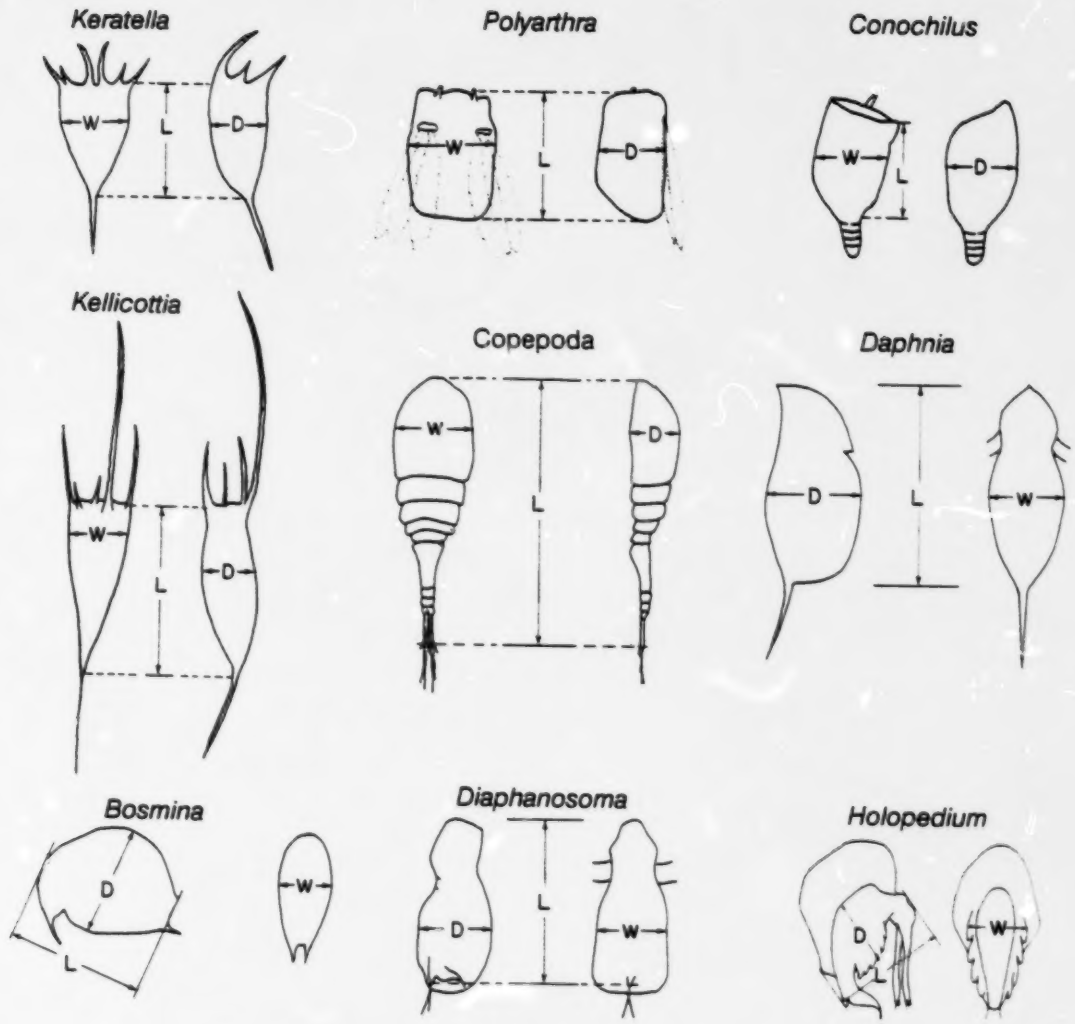

Figure 1. Axes of measurements on copepods, cladocerans and rotifers. L is length, D is depth, and W is width.

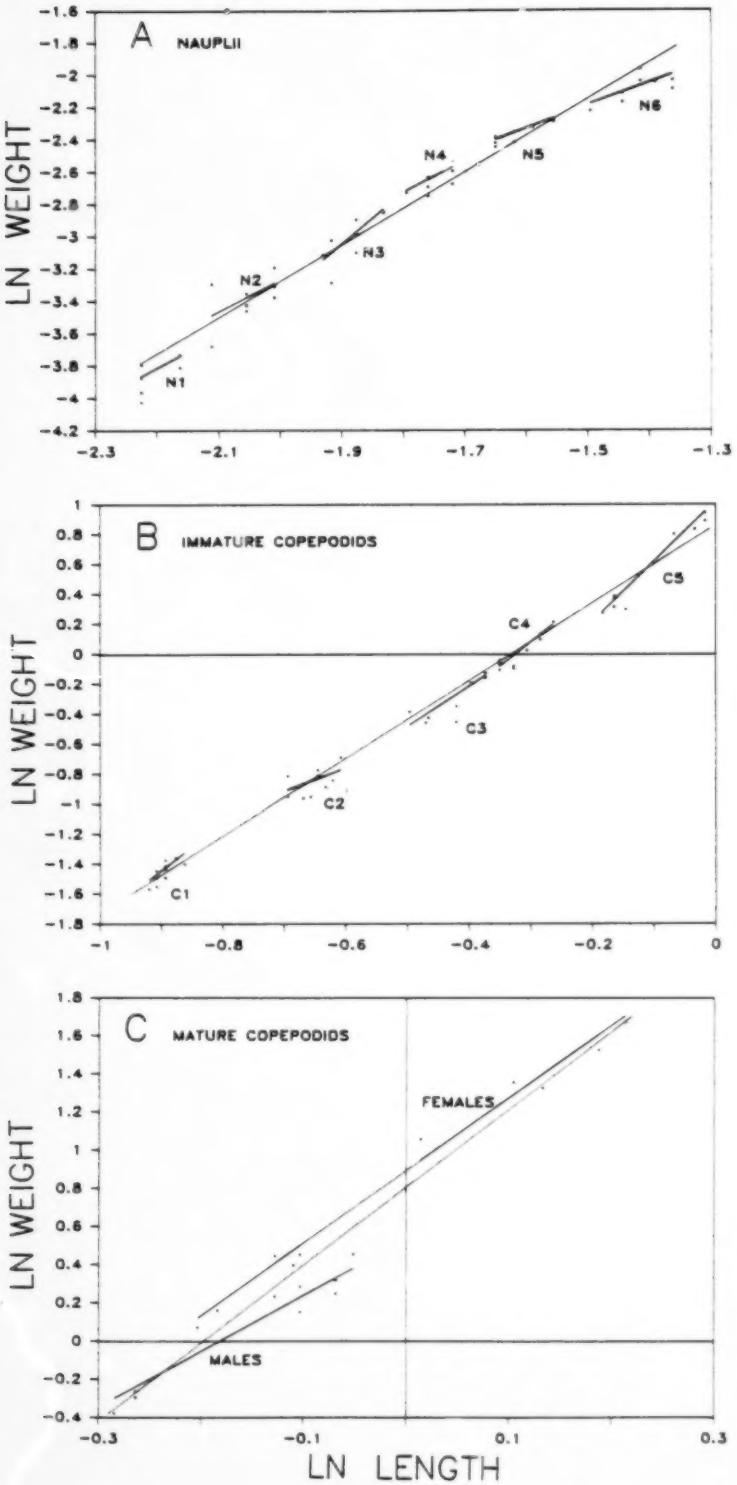

Figure 2. Length-weight regressions for life stages and groups of life stages of Cyclops bicuspidatus thomasi of ELA Lake 223.

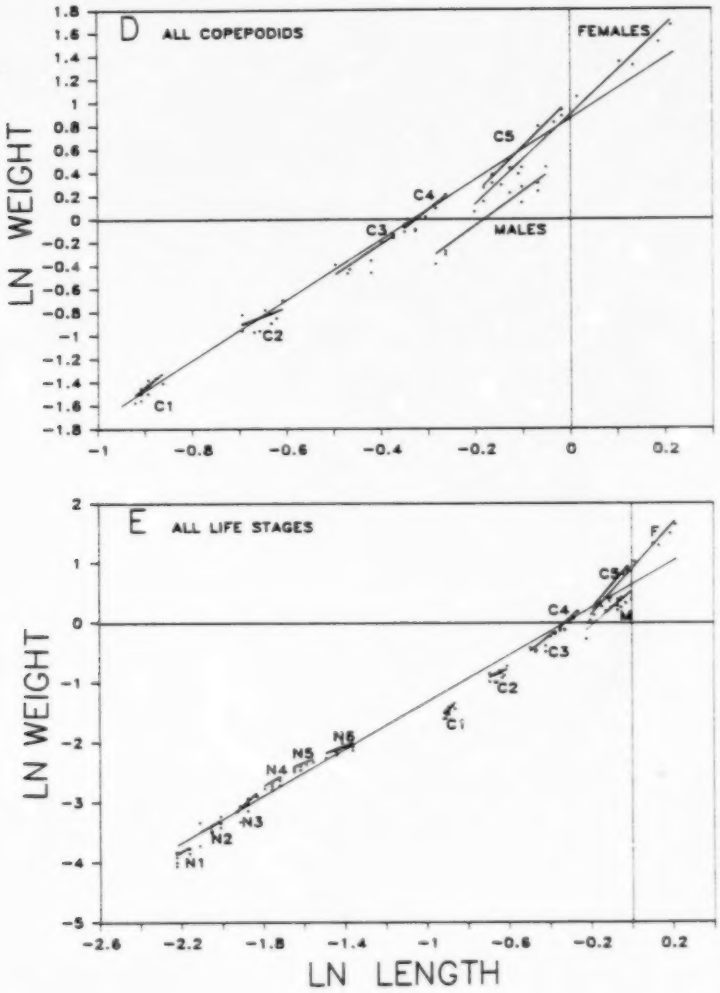

Figure Panel	Stages	N	lna	b ± C.I.	r	Range Length (mm)
A,E	N1	10	0.7407	2.0698 ± 2.0827	0.60	0.108-0.115
A,E	N2	10	0.6207	1.9446 ± 2.1542	0.57	0.121-0.134
A,E	N3	10	3.0265	3.1949 ± 1.8860	0.79	0.145-0.160
A,E	N4	10	0.8439	1.9824 ± 1.4980	0.71	0.166-0.179
A,E	N5	10	-0.0671	1.4132 ± 0.7128	0.83	0.192-0.211
A,E	N6	10	-0.1259	1.3716 ± 1.0147	0.72	0.224-0.256
B,D,E	C1	10	1.4416	3.2025 ± 2.0787	0.76	0.398-0.422
B,D,E	C2	10	0.1700	1.5429 ± 1.9702	0.51	0.499-0.544
B,D,E	C3	10	0.8679	2.6975 ± 1.1894	0.86	0.608-0.688
B,D,E	C4	10	1.0541	3.2314 ± 0.9980	0.93	0.704-0.768
B,D,E	C5	10	1.0238	4.0253 ± 0.5661	0.98	0.832-0.982
C,D,E	C6F	10	0.8938	3.8076 ± 0.3190	0.99	0.816-1.238
C,D,E	C6M	10	0.5305	2.9169 ± 1.1755	0.90	0.752-0.950
A	N1 to N6	60	see Table 9, Regression No. 39.			
B	C1 to C5	50	see Table 9, Regression No. 52.			
C	C6F + C6M	20	see Table 9, Regression No. 69.			
D	C1 to C6	70	see Table 9, Regression No. 90.			
E	N1 to C6	130	see Table 9, Regression No. 107.			

Figure 2. continued

APPENDIX 1

In two publications (Lawrence 1980; Lawrence and Holoka 1983) estimates of individual cladoceran biomass were made by assigning a value to a length interval. The length intervals were established by measuring 40 - 200 organisms as described in the text, calculating a dry weight for each and then ordering the data by length and identifying discontinuous groups. The calculated weights within each group were averaged to obtain the assigned biomass (Table A1).

This size-class method for measuring cladocerans gives rise to inaccurate biomass estimates since animals within a size class include a wide range of weights. For example, Daphnia galeata mendotae 900-1399 µm in length are assigned a value of 7.31 µg individual^{-1}. Using the Lake 223 regression (Table 10), an organism 900 µm in length weighs 4.37 µg and one 1399 µm long weighs 14.58 µg. Biomass values can be over- or under-estimated depending on the distribution of lengths in the sample examined. This method is no longer used in our laboratories.

Table A1. Length categories and their average dry weight for cladocerans from two lakes. N is the number measured in each category.

	Lake 223			Clay Lake		
	Length category µm	N	Average dry weight µg ± S.E.	Length category µm	N	Average dry weight µg ± S.E.
Alona rectangula				190-329	7	0.287 ± 0.08
				330-410	6	0.708 ± 0.18
Bosmina longirostris	200-250	26	0.358 ± 0.014	200-249	9	0.175 ± 0.03
	250-300	26	0.523 ± 0.030	250-299	11	0.256 ± 0.04
	300-350	15	1.019 ± 0.093	300-349	10	0.502 ± 0.09
	350-400	15	1.393 ± 0.091	350-399	6	0.839 ± 0.14
	>400	7	2.877 ± 0.351	>400	1	1.2
Chydorus sphaericus	as in Clay Lake			180-229	15	0.224 ± 0.035
				230-269	10	0.334 ± 0.055
				>270	5	0.741 ± 0.140
Daphnia galeata mendotae	300-499	5	0.72 ± 0.21	500-899	24	2.32 ± 0.99
	500-899	14	3.35 ± 0.81	900-1399	7	5.78 ± 0.57
	900-1399	20	7.31 ± 2.29			
	1400-1799	10	20.51 ± 6.43			
	1800-2299	17	43.34 ± 12.63			
	>2300	10	67.60 ± 14.67			
Daphnia retrocurva				700-899	18	1.11 ± 0.19
				900-1099	11	1.40 ± 0.07
				1100-1299	7	1.87 ± 0.58
				1300-1499	3	4.6
Diaphanosoma brachyurum	300-499	3	0.48	300-449	39	0.416 ± 0.111
	500-699	9	1.28	450-590	47	0.874 ± 0.221
	700-899	7	4.17	591-749	39	1.700 ± 0.516
	900-1099	5	7.07	750-890	19	3.278 ± 0.898
Sida crystallina	600-899	5	4.6			
	900-1099	3	7.7			
	>1100	2	25			

APPENDIX 2

In several cruises on three of the Great Lakes, B. Wilson[a], N. Watson[a] and J. Roff[b] collected samples of zooplankton. Selected specimens were dried and weighed by B. Wilson as described in Wilson and Roff (1973).

On Lake Ontario, a single station was sampled eight times during 1972 (Wilson and Roff 1973), in Georgian Bay of Lake Huron, eight stations were sampled once by Watson and Wilson during a single cruise, and on Lake Superior, 19 stations were sampled by Wilson during a single cruise. Samples from each lake were pooled and a single dry weight value produced for each species. Some of the Lake Ontario values appear in Wilson and Roff (1973) in somewhat different form. Mean dry weights of species from Lakes Huron and Superior (Table A2) are published here for the first time.

[a] Great Lakes Laboratories of Fisheries and Aquatic Sciences, Burlington, Ontario.
[b] Department of Zoology, Guelph University, Guelph, Ontario.

Table A2. Individual mean dry weights (µg) of crustacean zooplankton species of three Great Lakes. N is the number of individuals dried and weighed. F is female, M is male, C indicates immature copepodids.

Species		Lake Ontario		Lake Huron (Georgian Bay)		Lake Superior	
	Sex	N	µg	N	µg	N	µg
CLADOCERA							
Bosmina longirostris	F	92	3.0	295	1.4	102	2.4
Ceriodaphnia lacustris	F	60	1.9				
Chydorus sphaericus	F			7	1.1		
Daphnia galeata mendotae	F			45	4.0	372	20.3
D. retrocurva	F	67	3.3	100	4.8		
Daphnia species				580	4.0		
Diaphanosoma leuchtenbergianum	F			1	4.0		
Eubosmina coregoni	F			161	2.2		
Holopedium gibberum	F	2	12.5	98	14.5	1	33.0
Leptodora kindtii	F	4	12.0	2	20.5		
Polyphemus	F			4	28.0		
COPEPODA							
Cyclops bicuspidatus thomasi	F	297	3.8	194	4.9	39	4.1
	M	309	2.2	21	1.8	29	2.5
	C1-5	323	2.2	115	1.4	377	1.8
Diaptomus ashlandi	F					216	4.4
	M					165	3.8
D. minutus	F	120	5.0				
	M	105	4.0				
D. oregonensis	F	31	9.9				
	M	31	8.6				
D. sicilis	F	88	14.1			524	13.6
	M	95	10.7			359	10.9
Epischura lacustris	F			29	21.6	69	23.9
	M			6	15.2	61	18.8
	C1-5					2	7.0
Eurytemora affinis	F	16	7.7				
	M	25	5.4				
	C1-5	18	5.1				
Limnocalanus macrurus	F	110	53.2	62	53.1	221	56.3
	M	120	38.4	9	56.8	203	45.5
	C1	20	1.8				
	C2	28	2.3				
	C3	41	4.2				
	C4	38	7.9	4	11.5		
	C5	29	20.2	5	21.6		
Mesocyclops edax	F			23	8.4		
	C1-5			49	3.4		
Senecella calanoides	F					105	82.0
	M					85	68.9
	C1-5					2	56.0